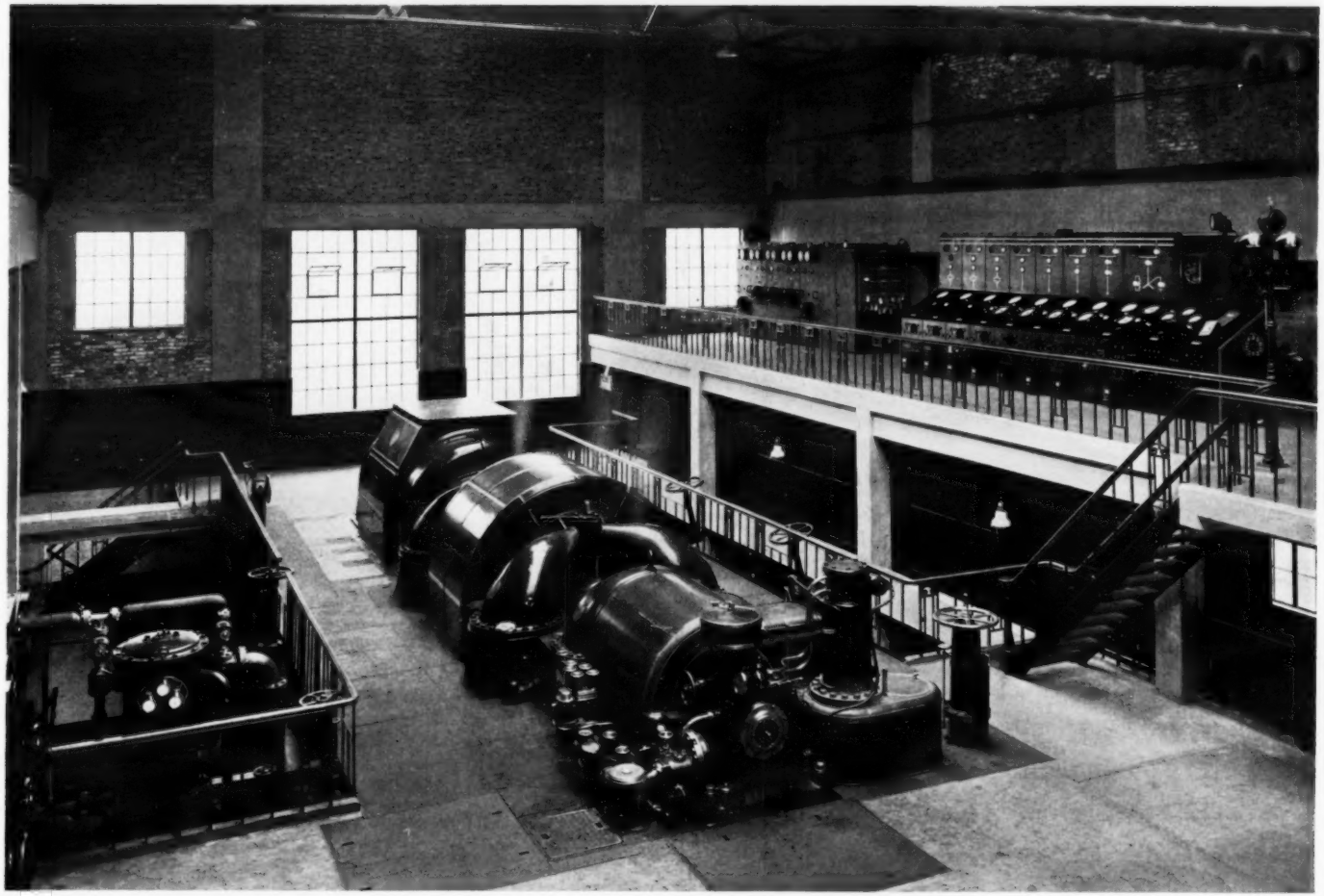
The ENGLISH ELECTRIC JOURNAL

Queen's House from Lincoln's Inn Fields.

All rights of republication, including translation of articles, are reserved.



THE TURBINE ROOM OF MESSRS. EDWARD LLOYD'S NEW POWER STATION AT KEMSLEY.
AN "ENGLISH ELECTRIC" COMPREHENSIVE CONTRACT.

The English Electric Journal

Vol. IV. No. 4 JULY, 1928 One Shilling.

CONTENTS.

PAGE

A Large Power Station for a Paper Mill - - - 93

Power Supply Progress - 102

Metal-clad Compound-filled Switchgear - - - - 105

High-Frequency Alternators for Induction Furnaces - 111

Application of the Change-Circuit Principle - - 113

High-Speed Induction Regulators - - - - 115

All Communications respecting Editorial Contents should be addressed to The Editor, The English Electric Journal, Queen's House, Kingsway, London, W.C.2.

EDITORIAL.

The English Electric Company has from its inception made a special feature of comprehensive contracts for the complete equipment of large Power Stations, such contracts including the buildings, foundations, coal handling plant, etc., as well as the prime movers, switchgear, transformers and auxiliary plant that is required. In previous numbers of the Journal, descriptions have been given of complete stations erected at Blackburn, Leicester, Preston and elsewhere, and in the following pages we give particulars of the latest comprehensive plant of this character that has been erected at the large Paper Mills of Messrs. Edward Lloyd at Kemsley.

The design embodies the latest developments in coal handling and ash conveying plants, in circulating water systems and in feed water heating arrangements, and it will be noted that the latest form of two-cylinder steam

turbine is adopted. The Station was erected in a very short space of time, the foundations being started in September, 1926, and the complete Station ready for operation in July of the following year. The power equipment in the Paper Works is not described in this article, but it is of interest to note that the Company has received orders for a total of about 30,000 horse power in motors for these Works.

Switchgear is another class of plant in which the Company specialises, and switchgear of all kinds, from the smallest to the largest sizes, is manufactured in the Switchgear Works of the Company. In the past numbers of the Journal various types of switchgear have been described, and we now add a description of the latest compound-filled gear that is manufactured in the Works. In the design of this gear many improvements have been incorporated, and large rupturing capacities are provided for in standard sizes.

A great advance has recently been made in steel works practice by the introduction of electric furnaces operated on the induction principle by very high frequency currents. The Company has prepared special designs of converting plant to give the high frequencies required, which are of the order of 1,000 cycles per second, and in certain instances of over 2,000 cycles per second. High frequency is adopted in order to obtain very high inductive effects, and while these effects are of the greatest value in the furnaces themselves, like effects will be developed in the generating machinery unless very special designs are adopted to overcome eddy current losses. The machines manufactured by the Company for this purpose have been very successful in operation and high efficiencies have been achieved. It is of interest to record that these high frequency sets have been supplied to steel makers not only in this country, but also in France and other places abroad.

Methods of improving the load factor of electric supply systems are attracting great attention at the present time, and the " Wilkinson " system of water heating for domestic and other purposes has recently been introduced and gives much promise for the future. Some reference to the " Wilkinson " system is made in the following pages, together with an account of a demonstration plant that has been installed at our Works. A vital part of the system is the Induction Regulator, a class of apparatus which has for some considerable time been an important item in the Company's manufactures.

A Large Power Station for a Paper Mill.

Through the courtesy of the management of Messrs. Edward Lloyd, Ltd., of Sittingbourne, we are able to put before readers of the Journal an illustrated description of one of the largest and most modern industrial power plants in this country. Not only have Messrs. Lloyd been intimately identified with the history of newspaper manufacture for nearly a century and attained the premier position as manufacturers of Newsprint paper in Great Britain, they have, in addition, established a reputation for continual progress in the adoption of the newest plant and methods of manufacture.

Concurrently with the building and equipment of a new Machine Room, probably the finest in the world, 360 ft. long by 112 ft. broad, they decided to establish a new station to supplement the electric power supply furnished by the existing power plants, which also supply the process steam required. The new Power Station and Boiler House has been built to contain 25,000 kilowatts of generating plant, with the necessary auxiliaries and control switchgear, while space is available for still further expansion when necessary.

In the summer of 1926, following the supply by this Company of a number of large electrical machines, instructions were received from Messrs. Lloyd to proceed with the carrying out of a comprehensive contract for a complete Power Station, including foundations, buildings, three 60,000 lbs. per hour water-tube boilers, a 12,500 kW. turbo-alternator set with twin surface condenser, switchgear installation, transformers and pump house.

Work was started on the foundations in September, 1926, and the power station was ready for operation in July, 1927. The illustrations on page 94 indicate the great rapidity with which the work was advanced.

The new mill and power station are at Kemsley, about three miles from Sittingbourne and half a mile from the River Swale, which is an arm of the sea dividing the Isle of Sheppey from the mainland. Messrs. Lloyd have their own private Dock, 750 ft. long and 250 ft. wide, equipped with

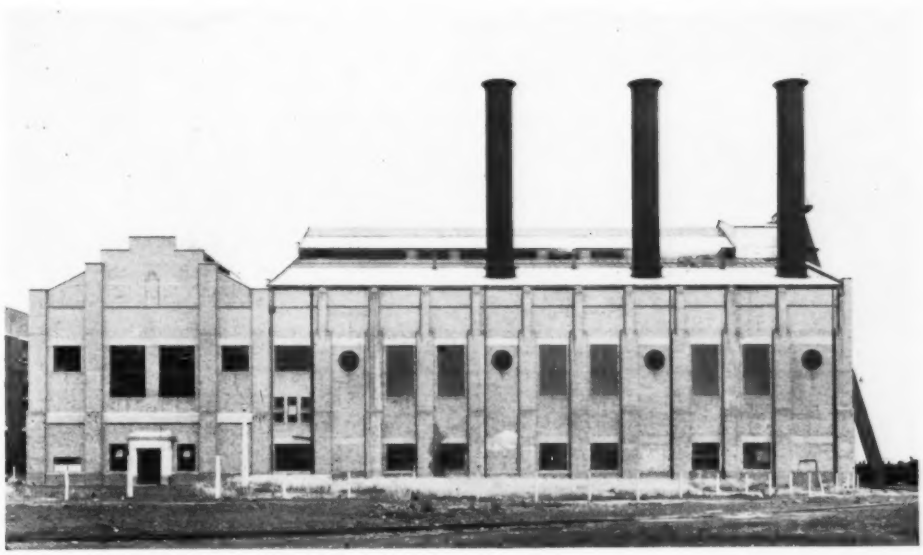
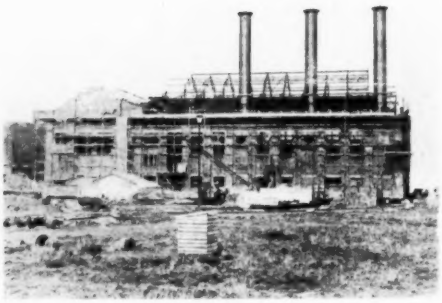


Fig. 1. Turbine Room and Boiler House of Messrs. Edward Lloyd's New Power Plant.

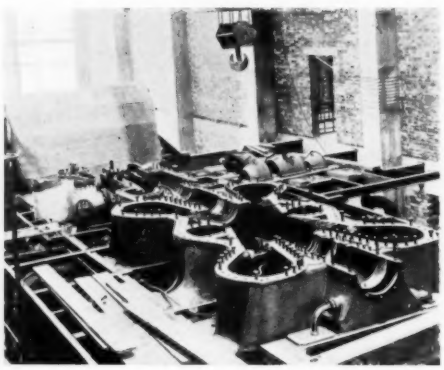
September, 1926.

December, 1926.

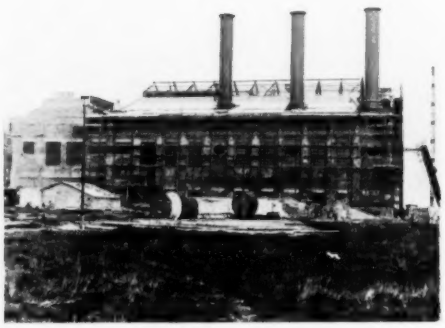
March, 1927.



April, 1927.



May, 1927.



May, 1927.

FIG. 2. VIEWS ILLUSTRATING THE RAPID PROGRESS OF THE CONTRACT.

modern electric cranes for handling all the raw materials required for the mills and the coal for the power house, and adjacent to the dock is a range of concrete coal bunkers. The Ridham Dock is connected with the Mills by a narrow-gauge railway over which three-quarters of a million tons of material are transported annually, while a branch from the Southern Railway also serves the Mills.

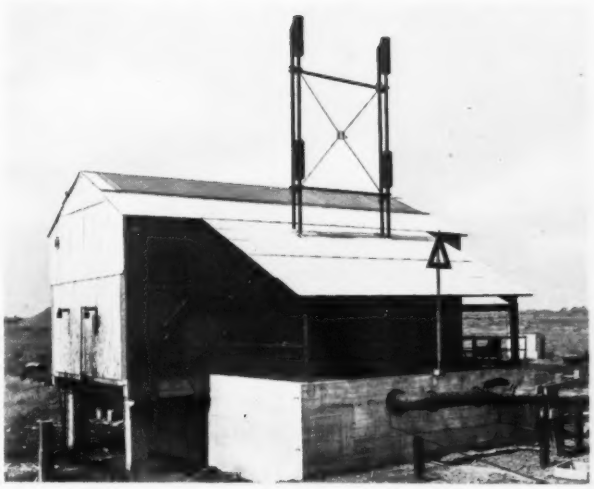


FIG. 3. THE CIRCULATING-WATER PUMP HOUSE.

Before proceeding to a detailed description of the various sections of the new power station it will be an advantage to survey briefly the general power scheme of the whole of the Mills at Kemsley and Sittingbourne and then to draw attention to some general features of interest in the new plant. The two older power stations at Sittingbourne and Kemsley respectively contain steam-driven generators designed to provide in an economical manner the large quantity of low-pressure steam that is required for process work in a paper mill. The original pass-out turbines in these stations were the first machines of that type to be installed in this country and consisted of a 2,400 kW. set at Sittingbourne and an 1,850 kW. unit at Kemsley. Later a 6,000 kW. Turbo-alternator giving pass-out steam at two pressures was installed at Sittingbourne, and these three turbine sets, together with a 1,650 kW. high-economy extraction-type cross-compound reciprocating engine, also arranged for passing out process steam, represent, even to-day, one of the most efficient industrial power plants. While these two stations give a supply of electric power directly and through transformers at various voltages from 430 to 6,600, according to the size and location of the motors, they are both linked up with the plant in the new Power Station on to a general 6,600-volt system, so that there is complete flexibility and the highest

FIG. 4. INTERIOR OF PUMP HOUSE.

factor of safety in respect of continuity of supply.

Special study was given in the planning of the new station to the provision of the best possible facilities for rapid overhaul and maintenance work, and this has resulted in ample space and light not only in the turbine room itself, but also in the boiler house, condenser basement, and in the accommodation of the various auxiliaries. This feature, which is well illustrated by the views shown in the Frontispiece and in Figs. 5, 6, 8 and 14, offers the most favourable conditions both for the staff and for the machines under their supervision, and undoubtedly conduces to the highest possible efficiency of operation and maintenance.

The choice of the site for the station was also a matter that demanded very careful study as there were many conflicting factors between which a balance had to be struck. The decisive factors proved to be its position in relation to the mills and the existing pass-out power station at Kemsley, and ease and economy of future extensions.

As already mentioned, coal is delivered to the Boiler House from Messrs. Lloyd's private dock by their own railway and also from the Southern Railway, most of the coal from the northern coalfields being sea-borne, while the supplies from the Kent Collieries are brought by rail. The trucks are tipped into a pit at the base of an elevator which lifts the coal to the top of the Boiler House and discharges it on to a belt conveyor, from which it is distributed into the overhead bunkers seen in Fig. 5. The weight delivered to the bunkers is recorded by an automatic Avery tipping machine and the quantity burnt on each grate is measured by Lea Coal Meters.

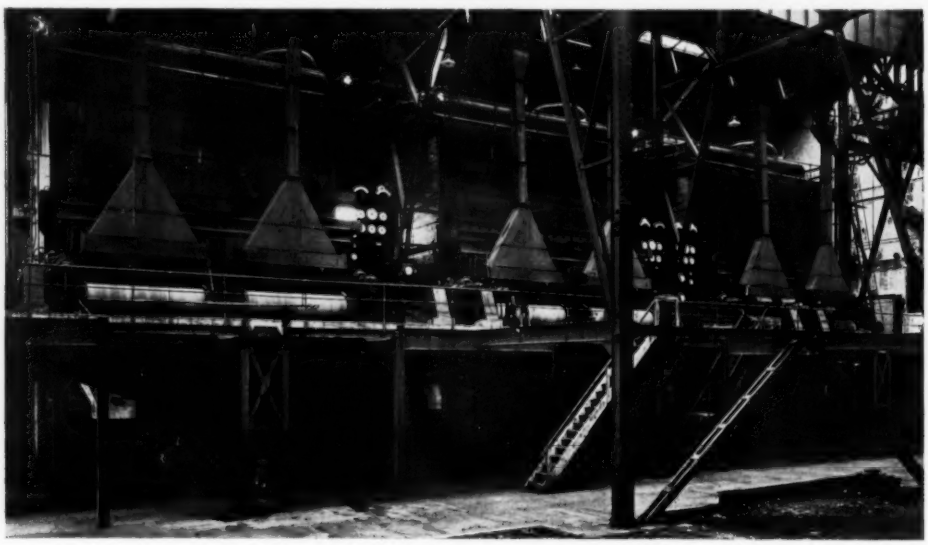


Fig. 5. Boiler House Firing Floor and Basement.

The ashes fall over the backs of the stoker grates and periodically are dumped down chutes by the firemen into a trench in the lower floor of the boiler house. A continuous flow of water down the trench carries the ashes to a pit outside, where the water passes through a screen and is pumped back again for re-circulation, while the ashes are lifted out by a crane into an overhead bunker.

The water for steam raising is obtained from

Messrs. Lloyd's private water works about four miles away.

Circulating water for the condenser is drawn from the Swale and is virtually sea water. A Pump House has been built just inside the sea wall which runs along the shore about 60 yards from low-water level, and from it two 48 in. diameter suction pipes run across the foreshore to well beyond low-water level. Each pipe terminates in a vacuum chamber in the pump house, and the water is drawn from these chambers through Rotary Screens by three 18 in. vertical spindle centrifugal pumps and delivered through a common 36 in. diameter main to the power station. For exhausting the vacuum chambers there are two reciprocating air pumps, one of which is sufficient for normal service. Fig. 3 shows the exterior of the Pump House, and Fig. 4 the interior, with the 175 H.P. slipring induction motors driving the submerged pumps.

After passing through the condensers the circulating water is discharged again at the nearest point on the shore, about half a mile from the inlet.

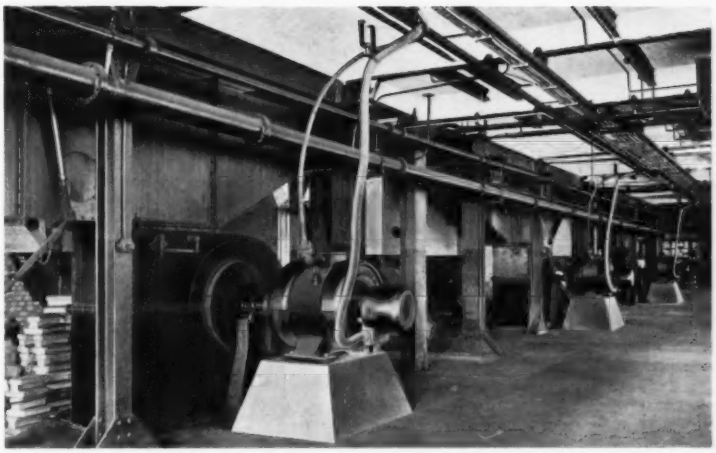


Fig. 6. Forced-draught Fans and Ash Chutes.

BOILER HOUSE.

At present there are three "Stirling" water-tube boilers, each having a normal steaming capacity of 60,000 lbs. per hour. For the plant now installed, this permits one boiler always to be kept as a stand-by unit. Steam is generated at 350 lbs. per square inch, superheated to a total temperature of 700 deg. F.

Each boiler is fitted with integral superheaters and Babcock & Wilcox chain grate compartment type stokers, and at the back of each unit is a Green's vertical tube economiser with separate flue passages and chimney. The feed water is delivered through a Venturi Meter into the economisers at a pressure of 400 lbs. per square inch by means of a Harland pump driven by a 150 H.P. squirrel-cage motor. A Weir steam-driven turbo-feed pump is installed as a stand-by.

The balanced draught system has been adopted, the forced draught fans being situated on the lower floor, as shown in Fig. 6, and the induced-draught fans on the upper or firing floor level between the economisers. All the fans are driven by variable-speed slipring motors of the canopy-protected type, while individual motor drives by standard machines are employed also for the stokers, economiser scrapers, coal elevator and conveyors, and the ash sluice trench pumps and ash crane.

TURBINE AND CLOSED-FEED SYSTEM.

The description of this section of the plant will be made clearer by reference to the Frontispiece and Fig. 7, showing two views of the turbo-alternator set, and Fig. 8 taken on the Condenser Floor. The main generating unit has an output of 12,500 kilowatts, and runs at a speed of 3,000 revolutions per minute. The turbine is designed to operate with a stop valve steam pressure of 300 lbs. per square inch, a total steam temperature of 700 deg. F. and a vacuum of 29 in. of mercury. The alternator delivers three-phase power at 6,600 volts and 50 cycles per second.

The turbine is of the latest two-cylinder impulse

reaction design of this Company, embodying a solid high-pressure rotor and built-up diaphragms, with a double-flow low-pressure cylinder exhausting into twin condensers. A number of important advantages are obtained by machining the high-pressure rotor out of a solid forging. In the first place, the strength of the rotor is assured and a hole is drilled from end to end of the shaft and the interior closely examined by suitable instruments to make sure the forging is sound. Another point is that the diaphragm gland leakage area is much reduced as compared with a built-up rotor, the diameter being that of the shaft as against that of the disc hubs. It is also possible to use smaller pitches between the stages for the same stress as in a built-up rotor, and consequently, owing to the small length between bearings the rotor can be designed to run below its first critical speed. Another refinement in this type of rotor which is directed also to a reduction of losses and increase of strength is the employment of a considerable number of stages of unusually small diameter.

The high-pressure cylinder exhausts into the centre of the low-pressure cylinder, the steam passing in both directions towards the exhausts, each of which is connected to one half of the twin condensers. This double-flow arrangement gives low steam exit losses and low blade stresses without complicated exhaust passages or fine axial clearances ; the use of twin condensers rendered possible by this design reduces the height and facilitates the lay-out of the condenser floor and permits either half to be out of commission temporarily. The low-pressure rotor also is of the solid type and shares the advantages mentioned above in connection with the rotor of the high-pressure end ; its first critical speed is well above its running speed.

Other special features which contribute in no small degree to the remarkable efficiency and good operating qualities of the " English Electric " two-cylinder turbine are the use of built-up diaphragms with nozzles milled out of solid steel blocks and the special attention given to the shape of the steam passages with a view to minimising losses due to turbulence and friction.

Reference has already been made to the twin

FIG. 7. H.P. END OF TURBINE, INSTRUMENT BOARD AND ILLUMINATED SIGNAL BOARD.

condensers into which the steam passes from the double exhaust of the low-pressure turbine. These condensers are of " English Electric " manufacture and designed to maintain a vacuum of 29 in. of mercury when condensing 96,000 lbs. of steam per hour and supplied with cooling water at 55 deg. F. The two units, which are connected by a balance pipe, have a total cooling surface of 14,000 square feet and require normally 11,350 gallons of cooling water per minute.

The condensate is drawn out of the condensers by two motor-driven Pervac extraction pumps, and then enters a closed feed-heating system, the primary object of which is the maintenance under all load conditions of the highest possible thermal efficiency. The feed-heating system may be considered in five units :—

(*a*) Generator Air Cooler.
(*b*) Drip Cooler.
(*c*) Air Ejector.
(*d*) Evaporator Heater.
(*e*) Bled Steam Heater.

The condensate passes through these units in

the order given, taking up heat from each, and in most of them performing some useful service in return.

The condensate main is connected by means of a surge pipe to a surge tank high up in the boiler house and the extraction pumps are capable of operating against the head in the surge tank; this arrangement ensures that the feed water enters the suction of the boiler feed pump under pressure and by taking up any surges caused by the automatic feed regulators on the boilers, avoids undue variation of pressure in the economisers. A float in the surge tank controls the supply of make-up water from a storage tank, and when the surge tank level falls, this water passes through a meter into the condenser. The condensate passes through a Venturi meter before entering the generator air cooler and from the latter passes to the drip cooler where it takes up heat from the evaporator and the heaters. It then passes to a Mirrlees Watson Steam Air Ejector,

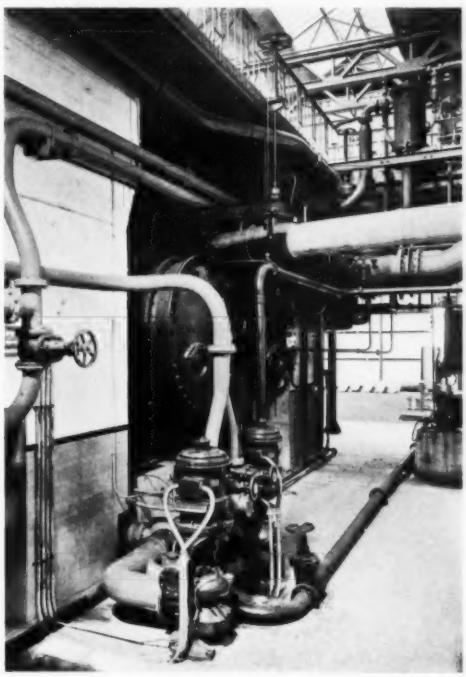


FIG. 8. CONDENSERS AND CONDENSATE PUMPS.

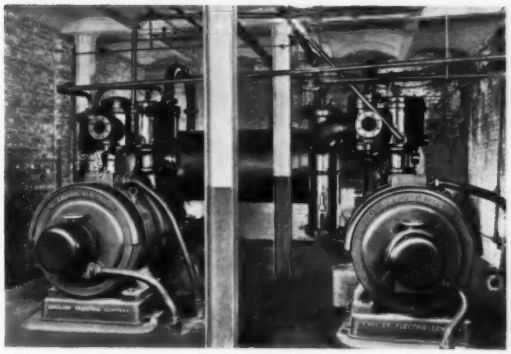


FIG. 9. MOTOR-DRIVEN AIR COMPRESSORS FOR MILL SERVICES.

condensing the steam supplied to the jets, and the first stage drips are led back to the drip cooler, and the second stage drips to a tank in the boiler house.

At this point the condensate leaves the turbine room, as it is a feature of this power plant that all the steam system auxiliaries beyond those already mentioned have been installed in the boiler house. This has a number of advantages, among which may be mentioned the greater simplicity of the turbine house, and more satisfactory division of duties between the staff.

From the air ejector the condensate enters the evaporator heater and condenses the vapour which has been distilled from the raw water by steam bled from the interconnecting pipe of the main turbine. Finally, the condensate passes through the bled steam heater, which is supplied from the same source as the evaporator heater, and has reached a temperature of 200 deg. F. when it enters the boiler feed pump.

The drips from the evaporator, its heater, and the bled steam heater are all drawn back to the drip cooler and on into the condensate pump suction.

The system operates quite automatically, a free and continuous flow of the drips being ensured by the difference of pressure in the heaters and the drip cooler. All drains and water from steam traps, etc., are led into the tank which receives the second stage condensate from the air ejector, and from there the water is transferred to the

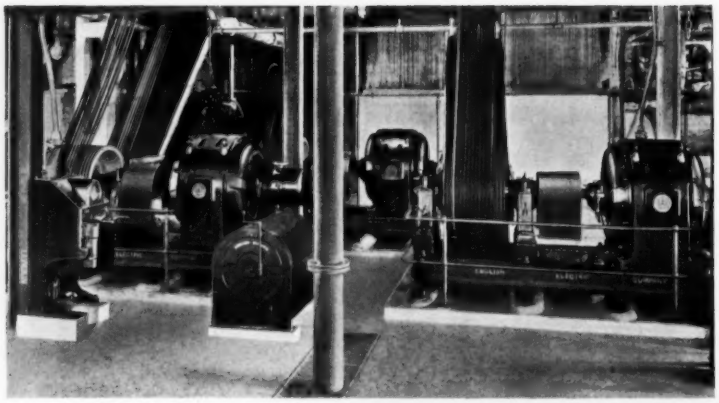


FIG. 10.
275 H.P. SLIPRING MOTORS OPERATING REFINERS BY ROPE DRIVES.

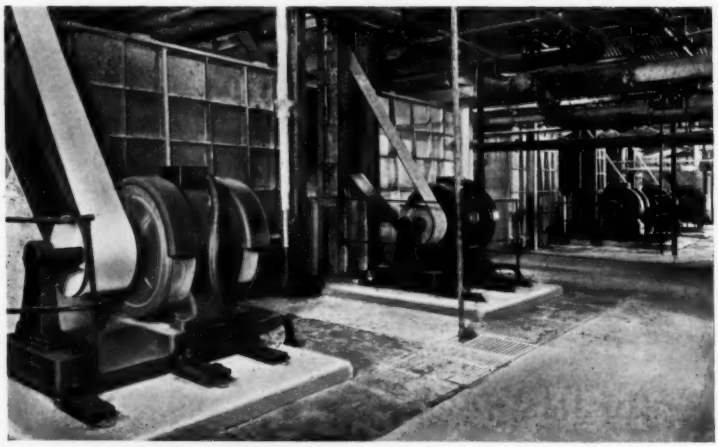


FIG. 11.
140 H.P. SLIPRING MOTORS DRIVING POACHERS.

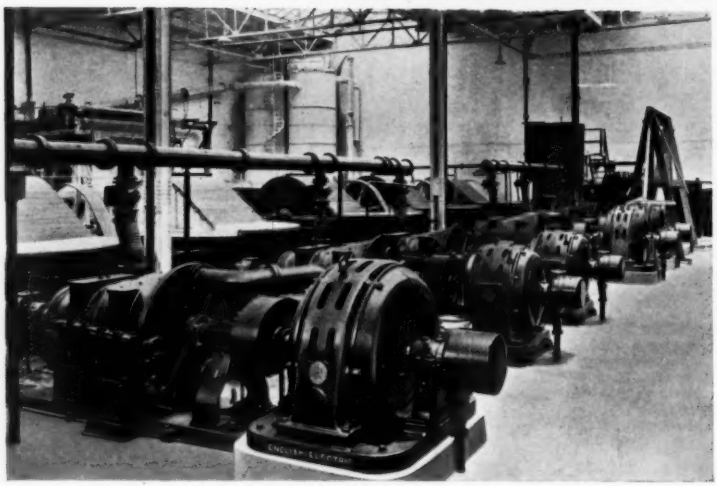


FIG. 12.
A GROUP OF REFINERS DRIVEN BY DIRECT-COUPLED MOTORS.

storage tank by means of an automatic steam lift trap.

When the evaporator is shut down because the storage tank is full, steam is bled from one of the lower stages in each half of the low-pressure Turbine and taken to the evaporator heater, which then becomes a low-pressure bled steam heater, and this steam performs the same duty as the evaporator vapour.

Thus it will be seen that every precaution is taken to retain all the distilled water in the feed system almost completely isolated from the atmosphere.

ALTERNATOR AND SWITCHGEAR.

The alternator conforms to the latest standard practice of the English Electric Company for 3,000 r.p.m. machines of medium size. Cooling is effected on the closed-circuit principle utilising a Premier air cooler supplied with cooling water from two separate sources ; one section is cooled by sea water taken from the circulating water main, and the other by the condensate as described on page 99. Provision is made for automatically opening the alternator casing to the turbine room in the event of the temperature of the circulating air passing the danger point. The operation of this automatic device is, however, under the control of the alternator protective system, and in the event of a fault developing in the alternator windings, the tripping of the main oil breaker prevents the opening of the alternator air damper.

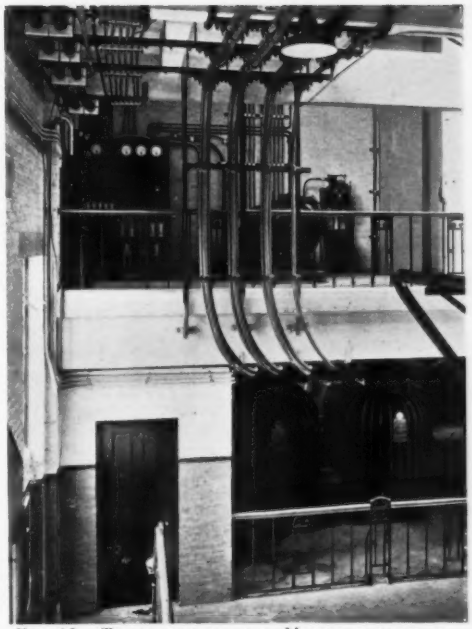


FIG. 13. TRANSFORMERS AND MOTOR-GENERATOR FOR POWER HOUSE SERVICES.

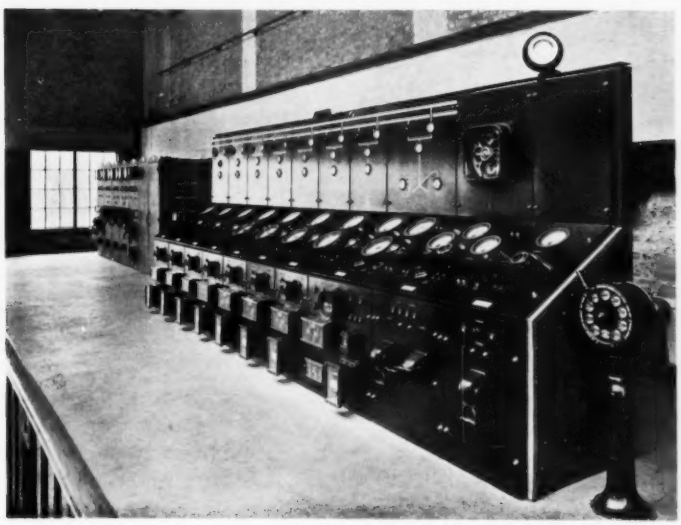


FIG. 14. MAIN CONTROL BOARD AND L.T. TRUCK-TYPE SWITCHBOARD.

As shown in the Frontispiece and Fig. 14, the main control board is placed very accessibly on a gallery in the turbine house. From it supervision can be exercised over every section of the load, and the main oil-immersed switchgear, which is housed in stonework cells on another gallery immediately beneath, is operated electrically.

The control board is of the desk type with the addition of vertical panels at the back, which carry a diagram with indicating lamps and the automatic voltage regulator. The indicating instruments and lamps, the keys

for electric operation of the E.H.T. switchgear, voltmeter and synchronising plugs, and the field regulator handwheels are mounted on the sloping face, and the front vertical panels carry the recording instruments, protective relays and operating handles for the excitation of the alternator, which may be taken from the direct-coupled exciter, from a special motor-generator set, or from a battery.

At the right hand of the control board is the turbine driver's telegraph and a standard carrying the synchronising instruments, and on the left of the gallery is a six-panel truck-type switchboard for the control of the low-tension supply to the station auxiliaries. This 440-volt supply is obtained from the substation shown in Fig. 13, which is situated on the condenser floor below the main switchboard gallery ; it contains two 800 kVA. transformers. A 50 kW. motor-generator set and distribution board on the gallery above the substation gives a direct-current supply at 110 volts for charging a 60-cell battery of 180 ampere-hours capacity, which furnishes the necessary energy for the electrical operation of the switchgear, and also serves as a stand-by for the excitation of the main alternator.

Owing to the distance of the pump house from the power station, duplicate 6,600-volt feeders have been run down to it and an 800 kVA. transformer provided, which gives the 440-volt supply for the circulating water pumps and their auxiliaries and local lighting.

The extra-high-tension switchgear embodies the latest improvements in the English Electric Company's stone cellwork design, and is arranged on both sides of a central structure so that the oil circuit-breaker cells are on one side and the busbar cells and isolating switches on the other. All the compartments are closed by steel doors mechanically interlocked by the operating keys on the control board. The circuit-breakers are of large rupturing capacity and are operated electrically from the control desk immediately above.

It will be seen that the entire lay-out is simple and well arranged, and although spacious and well lighted, all parts of the equipment are easily and quickly accessible.

Although it is hoped at a later date to describe in some detail the large amount of electrical equipment supplied by the Company for the operation of the Paper Mill Plant itself, it is fitting to conclude this article with reproductions from photographs of some of the drives. No less than 26,000 H.P. of English Electric motors are in operation in sizes ranging from $1\frac{1}{2}$ to 2,500 H.P. Those of our readers who are conversant with the conditions in paper mills know that it is impossible to avoid a general condition of dripping moisture, and it will be noticed from Figs 10, 11 and 12 that the protection afforded to the motors against this takes the form of canopies or hoods over the upper half of the ventilating openings. This design has been used very extensively for similar situations and has proved fully adequate.

In conclusion, we should like to express our indebtedness to Messrs. Edward Lloyd for permission to publish these particulars, and to Mr. A. A. Richards, the Chief Mechanical Engineer, and Mr. E. E. Fuller, the Chief Electrical Engineer, for the assistance received in preparing this article.

Power Supply Progress.

New Plant for Steam, Oil and Water Power.

One of the most striking developments in heavy electrical engineering since the War has been the enormous expansion of generating station capacity in all parts of the world. In addition to the great new stations and large extensions to existing stations that are a feature of this and other highly organised industrial countries, power stations for public and private service and for operation by water power, oil engines and steam generated by local coal of all grades are being built in countries where such a development was undreamt of ten years ago. This expansion is

due, of course, to the more general recognition of the advantages of electricity as a motive power for industrial and traction purposes, coupled with an intensive development of many hitherto unexploited and backward areas.

This activity is reflected in the variety of work in progress in the Company's Rugby Works. These Works specialise in the principal forms of Prime Mover, viz., Steam and Water Turbines and Heavy Oil Engines in sizes ranging from a few hundred horse-power up to the largest power station units.

The great demand for the large multi-cylinder 3,000 r.p.m. turbines which the Company has developed is indicated by the total of nearly 700,000 H.P. for which orders have been received within the last few years. This design has proved extremely attractive to power station engineers not only on account of the improved economy, in itself an all-important consideration, but also by reason of the subdivision of the total power between two or more cylinders which are individually of great strength and compactness, and facilitate maintenance.

There are now in course of production a 42,000 H.P. unit for **West Ham**, a 35,000 H.P. unit for **Leicester**, one of 42,000 H.P. for **Bradford**, and three of 33,000 H.P. for **Hungary**. The machine for Bradford is a repeat order following the successful operation of the 28,000 H.P. unit which was the first of the two-cylinder 3,000 r.p.m. turbines to be installed some years ago.

The multi-cylinder turbine is only one example of the active part played by the Company's designers in the advancement of power station practice, for they have done pioneer work also in the application of extra-high steam pressures and in the development of pass-out and back-pressure turbines for use in industrial works where large quantities of low-pressure steam are required for the manufacturing processes. An important order has been received for two of the largest back-pressure turbines so far contemplated. These are two 17,000 H.P. units for the Victoria Electricity Commissioners for use in connection with a State scheme of briquette production combined with electricity supply. Steam will be supplied to the turbines at a pressure of 565 lbs. per square inch and a total temperature of 725 deg. F., and the exhaust will be at a pressure of 55 lbs. per square inch. The turbines will be of the Company's Impulse type running at 3,000 r.p.m.

As illustrating the world-wide demand for the Company's steam power units, reference may be made to three of 10,500 H.P. each for the **Perak River** Hydro-electric Power Company and three of 4,000 H.P. for the **Belquas** station in Egypt. In both cases the turbines will be of the 3,000 r.p.m. single-cylinder design. Special mention may be made of a repeat order now in hand for a 17,000 H.P. turbine for the **Adelaide** tramways system, which follows the installation in 1926 of a similar machine.

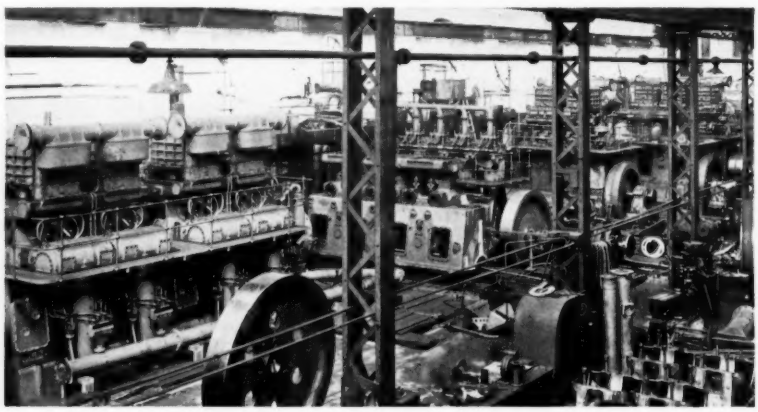
For all of the turbines mentioned, except, of course, the back-pressure units, the condensing plants also are being manufactured at Rugby, and for most of them the turbo-alternators are under construction at Stafford. The facilities offered by the Company for the construction of complete power stations are well illustrated by the description in this issue of Messrs. Edward Lloyd's station. The Belquas station, in Egypt, referred to above, is another example of a comprehensive contract of this character.

It is well known that for relatively small central stations in all localities and especially where fuel has to be transported over considerable distances, the Diesel type of heavy oil engine is the most economical prime mover yet developed. The illustration in this article shows the remarkable activity of the Diesel and Fullagar engine department at Rugby. For outputs of 750 H.P. and upwards the "English Electric" Fullagar opposed-piston engine has established itself as highly economical and reliable, and particularly valuable where space is limited. The engines shown in the picture include a 1,500 H.P. eight-cylinder unit for **Leatherhead**, seen on the left, 750 H.P. engines for **Horsham** and **Indore** (2), a 1,200 H.P. unit for **Malta**, and a number of Diesel engines of smaller size. Other Fullagar engines are on order for **Epsom** and **Bahamas** (2), and Diesels for **Belquas**, **Indore** and **Newbury**.

In water power engineering the Company occupies a unique position in having established, in

competition with foreign firms, the design and production of British water turbines of the largest sizes. The large units installed at the stations of the Tata Power Company in India and at the Sorocaba station of the Sao Paulo Company in Brazil, are well-known to readers, as are also the four vertical turbines in the Stonebyres and Bonnington stations on the Falls of the Clyde. Recently there have been set to work two 9,000 H.P. turbines at Mulungushi for supplying power to the Rhodesia Broken Hill Development mining company in the Malay States.

So far these notes have illustrated the great progress that is occurring in making electric power available throughout the world for purely utilitarian purposes. By a happy coincidence it is possible to conclude with a reference to an order just received for the electrical power supply equipment of the new regional station near Barnet of the British Broadcasting Corporation. While the capacity of this plant is small compared with that used in stations for the supply of



A Recent View in the Heavy Oil Engine Department, Rugby.

Company, and a 14,300 H.P. set at the Alouette automatic station of the British Columbia Electric Railway Company, the latter being one of the largest automatically operated hydro-electric stations yet built. Other turbines in process of erection or manufacture are five impulse units of 9,600 H.P. each for the Lochaber Power Company in Scotland, a 12,650 H.P. reaction unit for Lake Coleridge, New Zealand, and 1,650 and 1,560 H.P. impulse units for a tin

electricity for power purposes, its size and variety are instructive as showing the present-day development of radio service. The most interesting item is three 160 kW. motor-generator sets giving a direct-current supply at 12,000 volts. The main generating plant consists of four direct-current 200 kW. generators, and the order also includes a number of motor boosters, motor-generators, and main and auxiliary switchboards.

Peterborough's New Power Station.—The Official Opening will take place in September of the new station that has been erected on the Albert Meadow site adjacent to the older station which was reconstructed some five years ago. The buildings and equipment are of the most modern character throughout and include a 12,500 kW. two-cylinder turbo-alternator set and E.H.T. electrically-operated switchgear of "English Electric" manufacture.

Metal-clad Compound-filled Switchgear.

The development of switchgear during recent years has followed a clearly defined course with two very distinct objects as the goal. The first is reliability of operation and freedom from breakdown under all normal and abnormal service conditions, and the second is the safety of the operator. Service conditions vary, and the class of operator employed varies, so that a type of gear which may be perfectly satisfactory in some situations may be quite unsuitable for others.

For example, in substations and for numerous industrial purposes, ironclad, air insulated, draw-out type switchgear is quite suitable. This class of gear has been manufactured for many years at Stafford Works, and, in fact, this Company was amongst the first in the field—first with the SXA and SXC cast iron pillars, and later with the different sizes of truck type switchgear. All these have undergone modifications and improvements from time to time, and it is interesting to note that the SXA pillar is still in considerable demand, the larger SXC pillars being used to line up with SXA units for heavy currents. The economic limit of this class of gear is determined by the rupturing capacity of the oil circuit-breaker and is reached in the truck type at approximately 250,000 kVA at 11,000 volts.

Latterly, the development of metal-clad, draw-out type gear has been in the direction of compound-filled apparatus, which offers a useful alternative to stone cellwork and truck type gear in certain cases.

In weighing the advantages of the open type construction as against the compound-filled type, it must be remembered that each has inherent advantages and characteristics which are not obtainable in both types. For instance, the same degree of accessibility cannot be obtained in the enclosed type of gear as in the open type. On the other hand, complete enclosure of the gear simplifies erection, attendance and cleaning, facilitates the provision of interlocks and economises building space.

The expression " Compound-Filled Gear " has come into general use to denote the class of gear covered by the description which follows. The grades of compound used for filling vary considerably, and in place of an asphaltic compound, a thick oil can be used in the " English Electric " designs. The compound may vary from one having a high melting point, which pours at

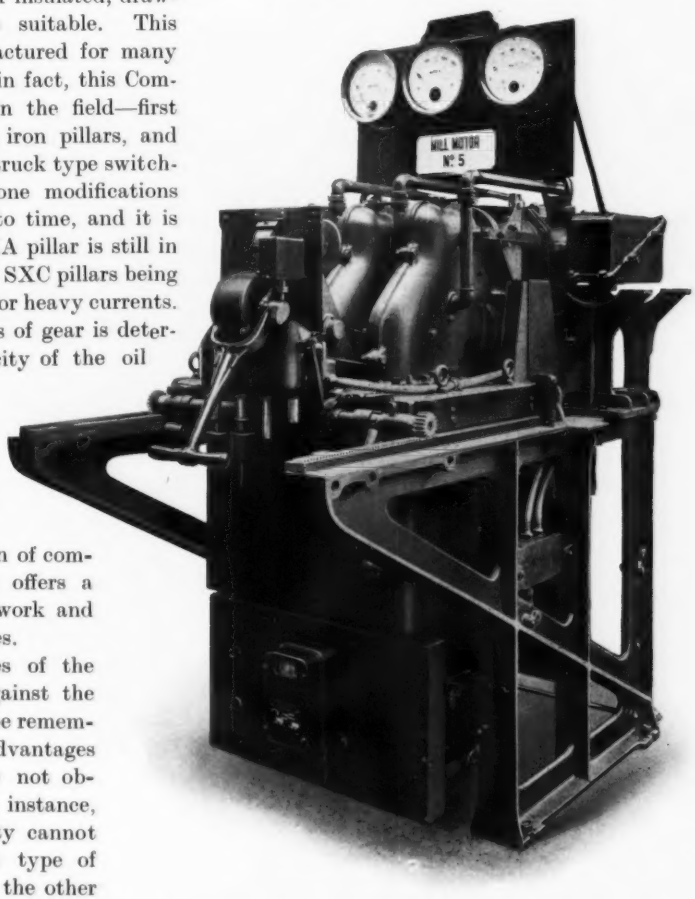


Fig. 1. 11,000-volt OLE Unit in Working Position.

120/140° C. and sets quite solid, to one which is poured at normal atmospheric temperature and remains semi-fluid. Solid compound is usually employed for busbar chambers, switch hoods, and other parts containing what may be considered the permanent connections; oil or semi-fluid compound is preferable in current transformer chambers, since it permits easier access to the transformers should they ever require to be changed.

Modern designs of Power Station and Sub-station switching units must make provision for duplicate busbars, which entails the provision of some method of changing over for busbar selection. The usual methods of changing over are—

(*a*) Removable plugs.
(*b*) Selector Switches.

Removable plugs have certain inherent disadvantages, chief amongst which is the time taken to change over from one set of plugs to another. Selector switches are usually oil-immersed and may be mounted either on the busbar portion or preferably in the circuit-breaker hood; by arranging them so that one set "makes" before the other set "breaks"; the changeover can be effected under load conditions, provided, of course, that the busbars have first been paralleled.

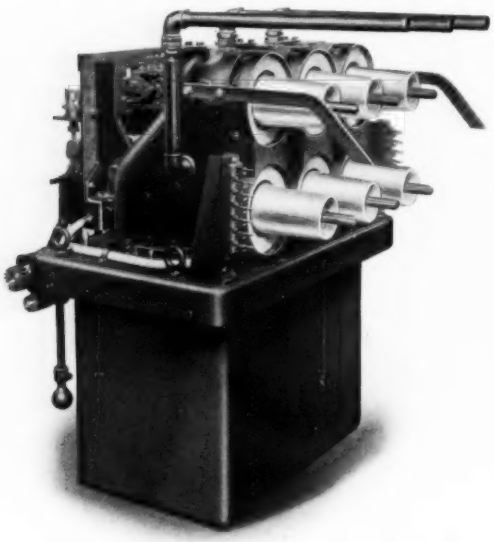


FIG. 2. DRAW-OUT OIL-BREAKER UNIT.

The "English Electric" compound-filled switchgear is of the horizontal draw-out pattern with or without duplicate busbars, and is made in three sizes of different rupturing capacity.

Class OLD with a rupturing capacity of 100,000 kVA is available for 400 or 600 amps. up to 11,000 volts.

Class OLE (see Fig. 6) has a rupturing capacity of 250,000 kVA and is made in 400, 800 and 1,200 amp. normal current ratings for use on systems up to 12,000 volts. Illustrations of this size are shown in Figs. 1, 2, 3 and 5.

Class OLF (see Fig. 4) has a rupturing capacity of 500,000 kVA and can be supplied in the following sizes :—

400 amps.	up to 33,000 volts		
800	,,	,, ,, 22,000	,,
1,200	,,	,, ,, 12,000	,,
2,000	,,		

Classes OLE and OLF can be provided with either plug changing or selector switches when double busbars are required; Class OLD is supplied with plug changing only.

The oil circuit-breakers for all types are of similar design, comprising a massive rectangular cast top plate, to which are bolted the circuit-breaker hoods carrying the isolating plug contacts and the operating mechanism. The three phases are carried on a single top plate, making a compact construction and ensuring accurate lining up of the plunger bar and its contacts.

The plunger bar insulator consists of a bakelised paper tube suitably reinforced by a steel centre and carried on rods running in guide tubes. By this construction, possible troubles incidental to the use of porcelain in tension as a plunger bar insulator are eliminated. The operation of the breaker is through steel lifting rods, and there are no levers inside the circuit-breaker proper. Oil dash pots are provided to cushion the shock on the opening stroke. The contact fingers are of the self-aligning type and sparking contacts can be provided if required. The moving contact

bar is of wedge shape, having a wide angle to facilitate entry into the contact fingers and to give a high contact pressure consistent with ease of closing.

The oil circuit-breaker vents are of the Company's patented type, which provides a baffled expansion chamber into which gas and oil may be forced upon the operation of the circuit breaker. In passing through the baffle plate, the gases are cooled, the oil loses its velocity and is separated from the gas. The gas then passes freely into the open through separate vent pipes while the oil remains in the expansion chamber and is returned to the circuit-breaker tank.

The tank is of steel plate of ample strength and is rectangular in shape. All three phases are accommodated in one tank provided with phase divisions welded to the tank sides. An adequate tank lining is also provided, spaced away from the walls of the tank so that there is a layer of inert oil between the lining and tank. The tank is securely bolted to the top plate, the bolt heads being in an accessible position for removing the tank when required.

Either hand operation or electrical operation may be provided as required.

The busbars, duplicate or single, are carried in chambers filled with solid compound, and are supported by insulators of high dielectric and mechanical strength fully capable of resisting the heat of the melted compound.

The busbars and connections are taped throughout their whole length with sufficient thickness of Empire tape to withstand the normal voltage of the system. The taping also acts as a soft cushion between the busbars and the solid compound, so that should there be any expansion of the bars due to heavy currents flowing, the resultant strains are not transmitted to the outer casing. The insulators themselves have a high factor of safety over the test pressure applied to a complete unit, so that with the addition of the taping, the electrical factor of safety is extremely high. The mechanical support given by the solid compound in the busbar chambers is of great service in resisting the stresses set up during short-circuit conditions.

The busbar chamber is filled with compound before leaving the Works, and is despatched with a flat plate over the filling opening. By filling under the most favourable conditions before dispatch it is assured that there are no air pockets, and the temporary filling plate ensures that during transit and erection the compound cannot become displaced. After erection on site

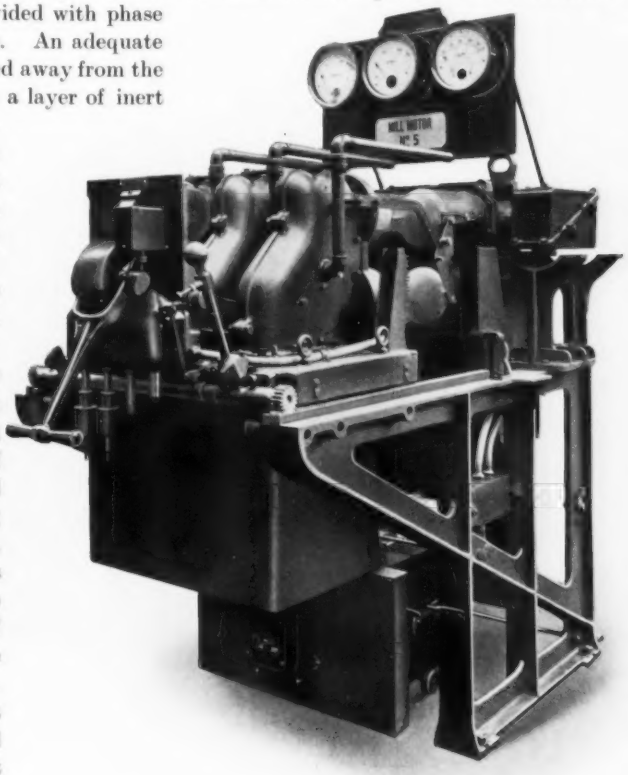


FIG. 3. OLE UNIT WITH OIL BREAKER WITHDRAWN AND ISOLATING SWITCH CONTACTS COVERED BY AUTOMATIC SHUTTERS.

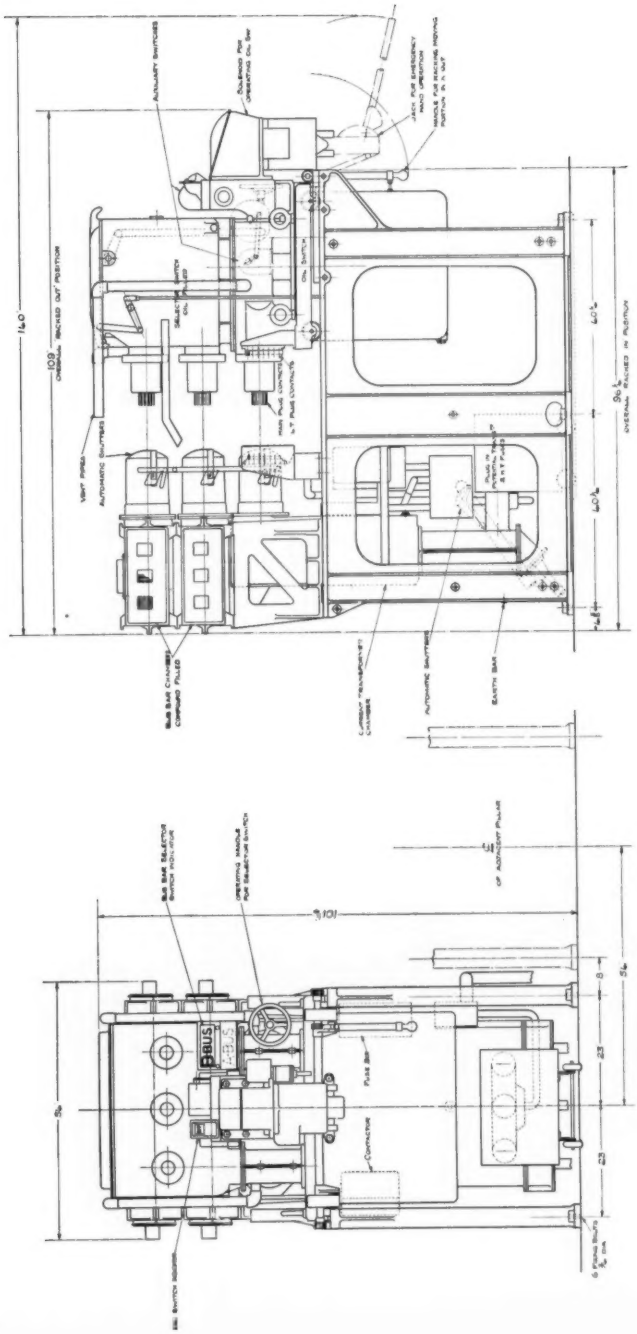


FIG. 4. GENERAL ARRANGEMENT OF OLF UNIT WITH DUPLICATE BUSBARS AND SOLENOID OPERATION.

the plate is removed and an expansion dome fitted in its place which allows the compound to expand without being forced out through the joints between the castings.

The isolating contacts are of the self-aligning type and are extremely liberally rated from a current carrying point of view. Up to 400 amps. the contacts are cylindrical in form ; above this current they are of the laminated strip pattern. Automatic dust-tight shutters cover the live contacts when the oil circuit-breaker is withdrawn, as shown in Figs. 4 and 5.

Below the busbar chamber is situated the transformer chamber, in which may be mounted one, two or three current transformers per phase, including any protective current transformers necessary. This chamber may be filled either with compound or mineral oil, but the latter is recommended as it facilitates the changing of current transformers should this be necessary at a later date.

When supplied, the potential transformer together with its fuse and limiting resistance, or alternatively with limiting resistance fuse, is carried on rollers in front of the current transformer chamber. The potential transformer plugs into contacts on the cable box, and, when removed an automatic dust-tight flap covers the live contacts.

Interlocking devices are provided to prevent access to the fuses until the transformer has been completely withdrawn from the live contacts. By this arrangement a fuse can be examined or replaced at any time without interfering with continuity of supply through the main oil circuit-breaker. The oil circuit-breaker is withdrawn on a horizontal machined track by a rack and pinion device operated by a hand lever.

The following locks and interlocks are provided, making the gear completely mistakeproof :—

(*a*) Protection of main isolating plug openings by automatic dust - tight shutters, which are raised by the action of racking the switch in, and closed by the reverse motion. Each set of shutters may be padlocked independently in the closed position.

(*b*) Protection of potential transformer isolating plug openings by a similar automatic dust-tight shutter, which may be padlocked in the closed position.

(*c*) Protection against attempting to withdraw the carriage with the circuit-breaker closed, the first movement of the racking handle tripping the oil circuit-breaker. This interlock also acts in the reverse direction to prevent plugging in with the circuit-breaker closed.

(*d*) Protection against lowering the tank with the switch plugged in.

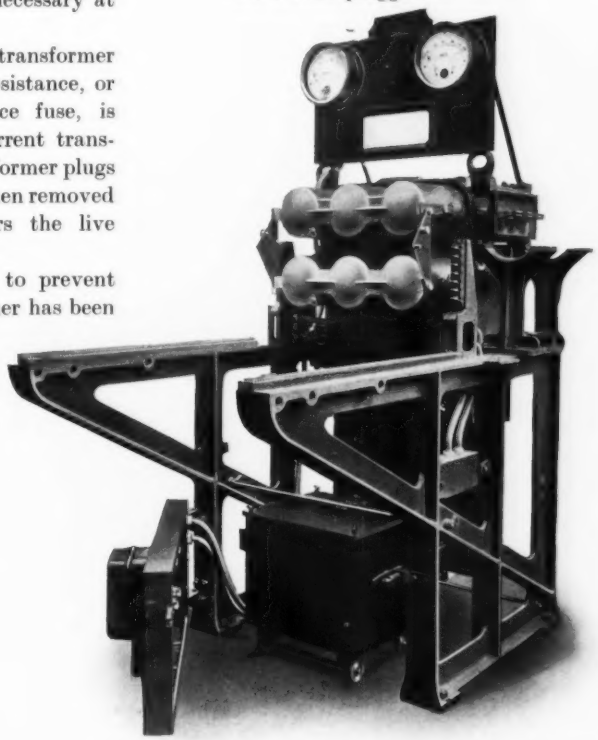


FIG. 5. OLE UNIT DISMANTLED TO SHOW AUTOMATIC SHUTTERS AND POTENTIAL TRANSFORMER.

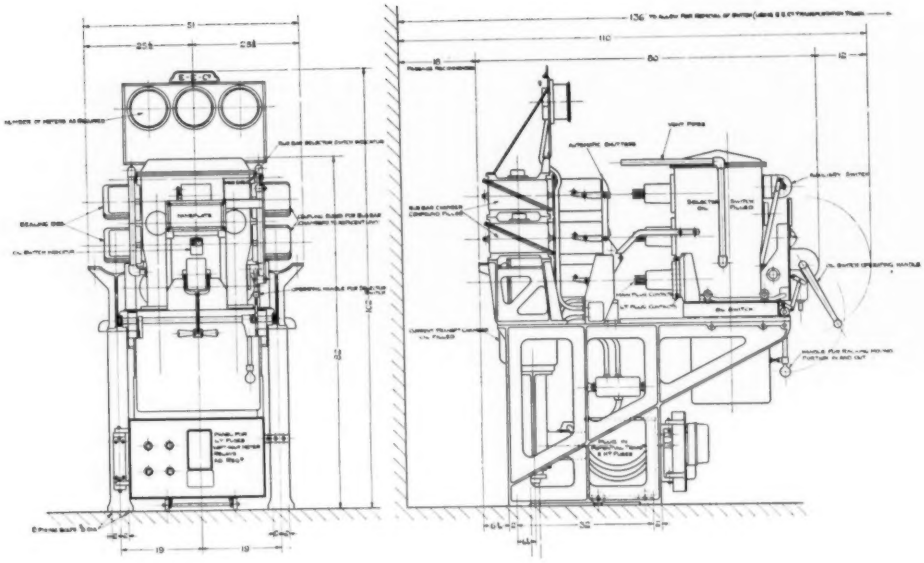


FIG. 6. OLE UNIT FOR HAND OPERATION, WITH DUPLICATE BUSBARS.

(*e*) Prevention of the circuit-breaker inching out due to vibration, a mechanical latch being fitted for this purpose. Even should the latch fail, it would not be possible for the breaker to inch out without the circuit-breaker being tripped automatically.

(*f*) Prevention of the circuit-breaker "jumping" when opening under heavy current by the provision of holding down devices at each corner of the top plate of the breaker.

Any desired system of padlocking can be provided in addition to the above.

For inspection and maintenance purposes, an extension piece for the secondary wiring can be provided. This enables the oil circuit-breaker to be plugged into the L.T. wiring whilst still isolated from the main circuit. The operating and protective circuits can thus be checked periodically with the greatest ease.

The cable boxes are designed on the usual lines for filling with solid compound and where necessary they are arranged to accommodate the fixed contacts for a potential transformer. An expansion chamber is fitted, which renders it impossible to over-fill the boxes.

Cable earthing is effected by means of an extension piece fitted to the lower set of the main plug contacts and an earthing connection fitted to the upper contacts. The switch is then racked in until the extension piece makes contact with the cable connections and the earthing is effected by closing the oil circuit-breaker. By this means the cable is earthed through the main circuit-breaker so that the operator is completely protected should he by any mischance attempt to earth a live cable.

A considerable number of units of the type described are now in course of manufacture, including a group of forty-seven of the largest size, for the complete equipment of the Switch House of a large London generating station.

High-frequency Alternators for Induction Furnaces.

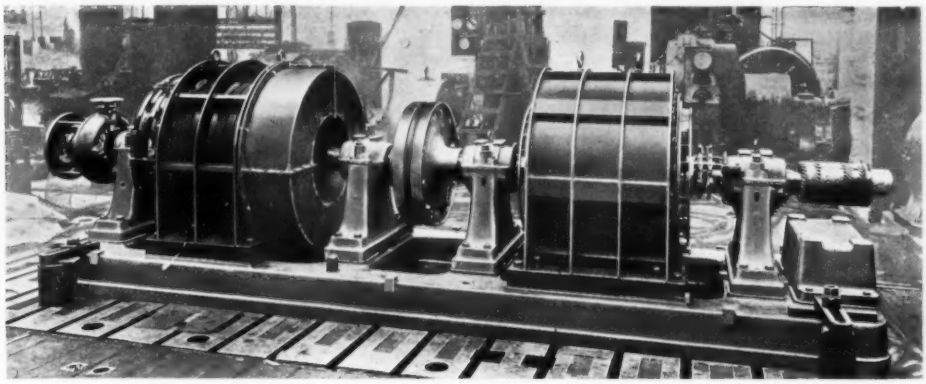


FIG. 1. 650 kW., 1,000 CYCLE, 1,500 R.P.M. MOTOR-ALTERNATOR SET UNDER ERECTION.

The long experience of The English Electric Company in the design and manufacture of electrical machinery has enabled them to make a valuable contribution to the development and adoption on a commercial scale of a type of electric furnace plant which has important advantages for the preparation of high-grade alloys of accurate composition.

The principle of using eddy currents for operating metal furnaces has been recognised as holding great possibilities ever since it was first suggested many years ago, but the practical application of the idea failed to achieve complete success until much higher frequencies were adopted than those used for electrical supply. Even then, the methods of generating alternating currents of very high frequency limited the efficiency and size of the plant, and it is only comparatively recently that alternators of suitable characteristics have become available.

The commercial development of induction furnaces operating at high frequencies has been due in large measure to the enterprise of the Electric Furnace Company, for whom a large number of special motor-generator sets have been made in sizes from 150 kW. to 650 kW., operating at frequencies from 500 up to several thousands of cycles per second. As an alternative to crucible melting or electric arc melting the new system has the great advantage that no impurities can pass into the metal; a further advantage lies in the fact that the electric currents induced in the molten metal set up a powerful circulation which causes intimate mixing of the ingredients

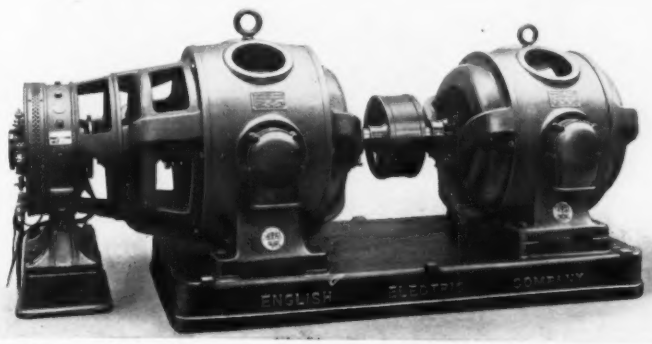


FIG. 2. 150 kVA., 3,000 R.P.M., 1,200 VOLT HIGH-FREQUENCY MOTOR-ALTERNATOR SET.

and consequently a highly uniform product. At the present time the furnaces are being used mainly for the higher grades of steel and for nickel and chrome alloys, and it is believed that a very marked advance has resulted in the quality of these materials.

In the furnace, an example of which is illustrated in Fig. 3, the high-frequency current is led round the crucible by means of a cylindrical water-cooled coil, protected from the crucible by asbestos sheeting and sand packing. The large currents induced in the metal within the crucible raise its temperature very quickly. The 150 kW. furnace shown takes a charge of about 450 lbs., and in the case of steel, melts this in approximately 50 minutes with a power consumption of 750 kelvins per ton. The older processes employing fuel fired furnaces required four to five hours for the same charge.

Fig. 1 shows a 650 kW., 1,000-cycle, 1,500 r.p.m. motor-generator set on test at Stafford Works, and Fig. 2 a 150 kW., 3,000 r.p.m. set

FIG. 3. INDUCTION FURNACE FOR SPECIAL TOOL STEEL.

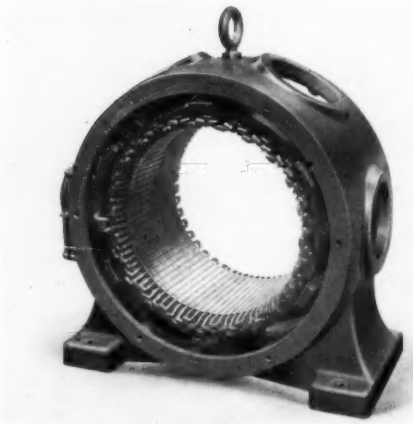


FIG. 4. STATOR OF HIGH-FREQUENCY ALTERNATOR.

with its own direct-coupled exciter, ready for installation. This set, the second manufactured for a Continental country, is for use with a one-ton furnace and represents the largest equipment of the kind to be built.

The success which has attended the operation of these alternators is due to very careful design and manufacture directed towards reducing to a minimum those losses which are a function of the frequency, and also to the accurate balancing of the rotating parts. An 150 kW., 1,000-cycle, set recently completed, gave an overall efficiency of over 81½ per cent.—an extremely good performance for a motor-generator of that output and frequency.

Attention may be drawn to the construction of the stator frames of the alternator and induction motor of the set illustrated in Fig. 1, which it will be seen is of the welded steel plate type. The field in which this construction offers advantages over cast iron or steel is being closely explored by this Company, as it has been their practice for some years past to take full advantage of electric welding in the manufacture of a number of products.

In view of the high speeds at which these sets have necessarily to run, the rotors are designed somewhat on the lines of small turbo-alternator rotors. Special bronze keys are employed for retaining the pole coils in place, and manganese bronze end bells for enclosing the winding over-

hangs. Axial ventilation is adopted and mica insulation is used for both the rotor and the stator windings. Figs. 4 and 5 show the stator and rotor of an 150 kW. alternator. As the power factor of an induction furnace load is extremely low it is customary to install static condensers in order to bring the alternator power factor to unity. The condensers are divided into sections which can be switched in as required, according to the circuit conditions as shown by suitable instruments mounted on a switchboard near the furnace. The capacity required and therefore the size of the condenser bank being inversely proportional to the frequency and voltage, it is clearly advantageous from this point of view to design the plant for the highest possible values of these quantities.

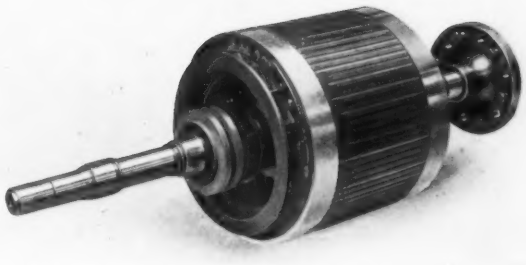


FIG. 5. ROTOR OF HIGH-FREQUENCY ALTERNATOR.

The Application of the Change-circuit Principle.

A number of Power Station and Consulting Engineers from all parts of the country visited Stafford Works recently for the dual purpose of seeing a demonstration of the "Wilkinson" change-circuit system, and inspecting a large number of interesting products in course of manufacture in the Heavy Machine, Transformer and Switchgear Departments.

In view of the great interest shown in the change-circuit as explained and demonstrated on that occasion, it is believed that readers will welcome a few notes on the subject from the point of view of the practical application of the system to constant-voltage networks.

Fig. 1 is a general view of the change-circuit demonstration apparatus consisting of an Automatic Induction Regulator seen on the right, a hot water storage tank in the centre connected to several types of domestic hot water apparatus, an instrument board and diagram of connections, and a variable artificial constant-voltage load not seen in the picture.

It will be remembered that this system aims at a high and constant load-factor, and that this is achieved by adding a supplementary distributor cable to an existing distributing system, and using this new cable and one of the constant-voltage mains for giving a variable-voltage supply to hot water storage tanks on the consumer's premises.

The variation of the voltage in this so-called change-circuit is brought about automatically by an Induction Regulator installed at each substation or other distribution point, in such a way that the sum of the normal and change-circuit loads remains approximately constant. When the ordinary constant-voltage lighting, power and domestic load diminishes, the voltage on the change-circuit is increased, and when the constant-voltage load rises, the change-circuit voltage is reduced.

In the demonstration apparatus this scheme of operation was shown by means of 3 ammeters connected respectively in the constant-voltage circuit, the change-circuit and in the circuit of the main supplying the whole load. The constant-voltage load of lamps and resistances was altered as desired, and the operation of the relay apparatus and the Induction Regulator could then be

observed as it restored the total load always to the same value, as shown on the total-load ammeter.

The hot water tank was provided with a dial type thermometer to indicate the temperature of the water in it.

While the principle as outlined above, has no doubt been widely understood, some doubt has been expressed as to whether the surplus generating station capacity available with present day load factors is in any way adequate to supply sufficient power for the hot water requirements which might be expected on the introduction of the change-circuit.

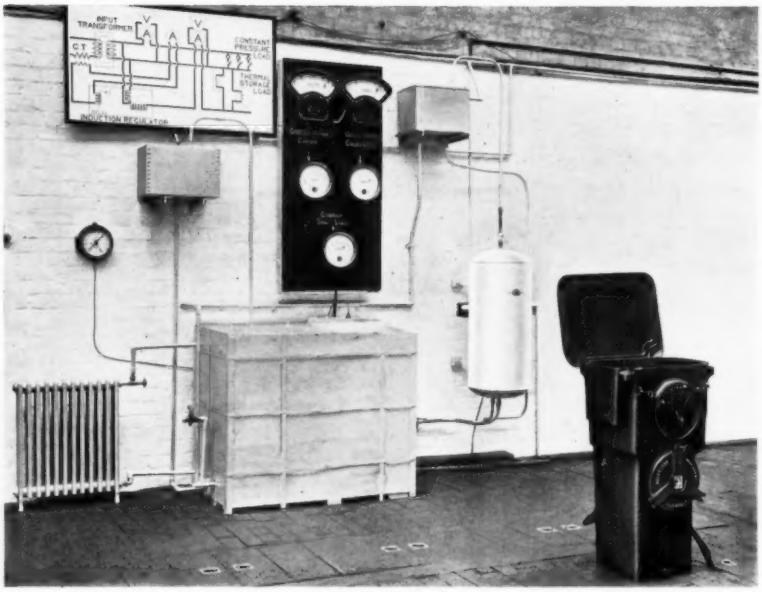


FIG. 1 "WILKINSON" CHANGE-CIRCUIT INSTALLATION AT STAFFORD WORKS.

Another question that has frequently been raised concerns the capital outlay which the introduction of the system on an existing network would involve. Before giving some figures relative to the first of these two questions, it may be pointed out that in the natural course of things the system would be introduced gradually and applied in the first instance to the most favourable areas such as new housing schemes or perhaps in a single factory or Institution, or for a group of such consumers where the hot water consumption is considerable. Without necessarily extending the change-circuit immediately to large areas, it is possible, as has been shown by calculation, to put in a single installation of say 75 kW., and to supply the hot water load at an attractive tariff which gives an economic return on the capital outlay.

However successful electric supply undertakings may be in increasing power and heating loads on their systems, there will be a definite limit, and that a not very high one in most stations, to the improvement of load factor, unless a night load of considerable magnitude can be obtained. The change-circuit is a serious attempt to solve this problem, and it is hoped that the completion of an initial installation in the near future will provide valuable data for further developments.

Returning to the question of whether the available power is commensurate with an adequate hot water supply, the problem may be analysed either from the consumer's or the Power Station end ; both methods are instructive.

Looking at the matter from the consumer's end, it is necessary to make certain assumptions with regard to the average amount of energy required in a household for house heating, hot water heating, lighting and other purposes. It is well known that these figures differ very widely for various classes of property and between similar houses in the same district, but after careful consideration of the results that have been published, it appears that the following assump-

tions can be taken as a reasonable basis for a calculation of this kind, assuming that a hot water supply from a change-circuit has been installed.

AVERAGE CONSUMPTION FOR A HOUSEHOLD OF 4 PEOPLE.

Lighting	300	units per annum
Small power uses ...	100	,, ,, ,,
Radiator heating ...	1,000	,, ,, ,,
Central heating ...	2,000	,, ,, ,,
Hot water	3,000	,, ,, ,,
Boiling	400	,, ,, ,,

This gives a total of 1,800 units per annum taken from the constant voltage supply, and 5,000 units taken from the change-circuit. On the basis of a 25 per cent. load factor on the constant voltage system, there would be $1,800 \times 3 = 5,400$ units available for the change-circuit, assuming the total load factor to be unity. This quantity of electrical energy is equivalent to 15 millions of B.T.U. of useful thermal energy, sufficient to heat 72 gallons of water per day from an average temperature of 50 deg. F. to 120 deg. F. It has been assumed that, in general, the central heating would be supplemented by radiators or other local heating and additional appliances would be installed for boosting the temperature of small quantities of water required for general domestic purposes.

These calculations, while necessarily of an approximate nature, serve to show that there is an adequate reserve of off-peak energy to meet all probable requirements, and it is believed that calculations based on the actual conditions ruling on many supply systems, will confirm this view.

In the case of large consumers, it would be economical to install a change-circuit Induction Regulator on the consumer's premises, and we may take as a further example an Institution having a maximum demand of 100 kW., at a load factor of 25 per cent. This means that the equivalent of 100 kW. for 18 hours per day is available for heat storage from the change-circuit, and it can be shown that in this case the off-peak energy is sufficient to heat 60 rooms of some 2,000 cubic feet capacity, and to give a daily hot water supply of over 6,000 gallons at a temperature of 120 deg. F.

The possibilities of the proposed system cannot be properly gauged without experience of its practical operation, particularly as its introduction would almost certainly lead to the more extensive use of electrical energy for all domestic purposes, and render possible more attractive tariffs for heating and cooking loads.

High-speed Induction Regulators.

On the occasion of the demonstration referred to in the above article, an interesting example was seen of the latest developments in " English Electric " Induction Regulators. This took the form of a Regulator equipped with specially designed operating gear, capable of actuating the Induction Regulator with such rapidity that the entire range of voltage regulation could be obtained almost instantaneously.

The Induction Regulator in question is illustrated in Fig. 1, and has been built for use on the bulk supply taken by the Richmond Electric Power Supply Co. from the Lot's Road Power Station of the Underground Railways.

It is obvious that in taking a public supply for lighting and general purposes from a large traction Power Station there is a risk of considerable and rapid voltage variations, which would not only interfere with the public service, but might actually cause damage to the connected apparatus.

Consideration of the utility of installing an Induction Regulator in order to combat these voltage variations, showed that an ordinary motor-operated regulator giving its full range of regulation in, perhaps, half a minute would not assist materially in overcoming the trouble, and it was evident that a new type of operating gear had to be evolved.

The experience of this Company in the design

of Governors for Steam and Water Turbines and their earlier adaptations of such apparatus to the operation of controllers for large rolling mill motors led their designers to look into the possibility of using some form of Servo-motor. After investigation, a suitable gear of this type was adapted to the purpose in view, consisting of an oil Servo-Motor in which the valves are controlled by means of an electric relay actuated in the usual way according to the voltage of the supply circuit. The whole of this apparatus is mounted on the top of the Induction Regulator tank and rotates the shaft of the regulator through suitable gearing.

The regulator in question is for the control of a 300 kVA single-phase 440-volt feeder supplied from 11,000-volt $33\frac{1}{3}$-cycle mains, and its duty is to provide voltage compensation within the limits of plus and minus 10 per cent.

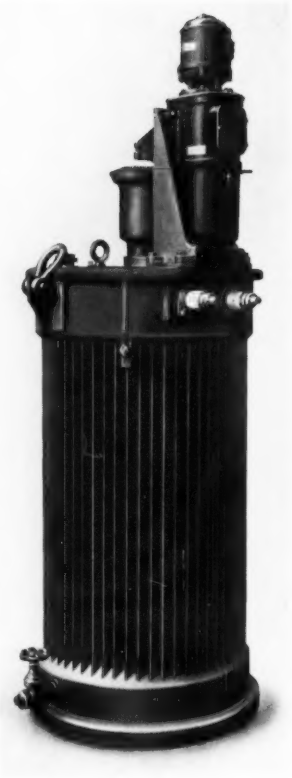


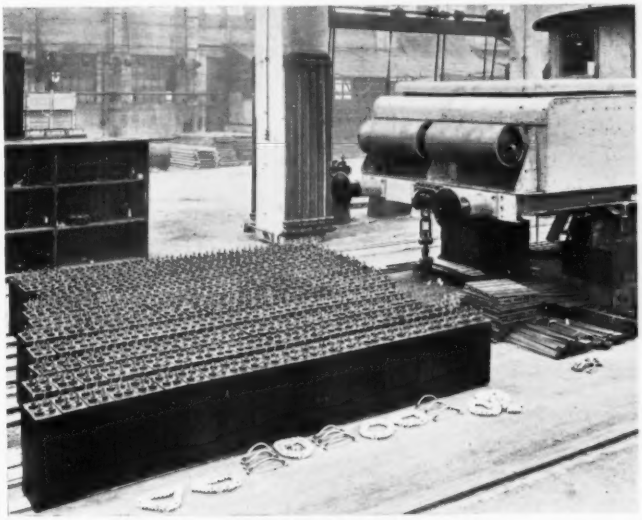
FIG. 1. HIGH-SPEED INDUCTION REGULATOR.

Tests on the completed apparatus have shown that the complete range of regulation of 20 per cent. can be achieved in $1\frac{1}{4}$ seconds, which is a result so much in advance of anything previously attained that it is hoped to improve very considerably the operating conditions on the Richmond supply.

A similar regulator has been supplied for an entirely different class of service, viz., the maintenance of an approximately constant current in operating a large electric welding machine. Although the process of electric welding naturally introduces very extreme and very sudden variations in the circuit resistance and therefore in the voltage of the generator, it is of the greatest importance to operate as far as possible with a constant-current arc. In the case in question the welding load of about 100 kVA is taken from a Motor-Generator, and it is impossible to avoid wide fluctuations in voltage as the circuit conditions vary from no-load up to the maximum current. It was therefore decided to insert an Induction Regulator between the alternator and the load, and to equip it with high-speed operating gear, with a view to maintaining constant current throughout the welding process.

The regulator has been designed for an output of 100 kVA. at any frequency between 60 and 100 cycles per second, and for a voltage variation from 200/550 volts.

It is confidently anticipated that when these regulators have been put into service under practical conditions they will afford valuable data for the development of similar units for a variety of purposes.



For use in India

D.P. KATHANODE BATTERIES

awaiting fitting into one of the two Electric Locomotives made by The English Electric Co., Ltd., for the Bombay, Baroda & Central India Railway. Batteries have to be good for use in the East—hence the choice of Kathanode.

Booklets Free.

THE D.P. BATTERY CO., LTD.

Bakewell, Derbyshire.

London Office : 11, Victoria Street, S.W.1.

S.D. 143

ELECTRIC FURNACES FOR ALL PURPOSES

SUCH AS

MELTING OF STEEL, IRON, BRASS, NICKEL, CUPRO-NICKEL, NICKEL-SILVER, PLATINUM, &c.

ANNEALING OF STRIP, BAR, SHEETS, WIRE, &c.

POTTERY ANNEALING

MANUFACTURE OF FERRO-ALLOYS & CALCIUM CARBIDE

HEROULT
AJAX-NORTHRUP
AJAX-WYATT
EFCO RESISTANCE
(WILD-BARFIELD AND OTHER TYPES)

ELECTRIC FURNACE CO. LTD.

17, VICTORIA STREET, LONDON, S.W.1.

Mica, Leatheroid, Vulcanized Fibre

EMPIRE CLOTH AND TAPE

Bakelite Sheets, Tubes, Spools, etc.

for Oil-immersed Apparatus and Transformers.

BAKELITE RESIN, VARNISH & MOULDING POWDER.

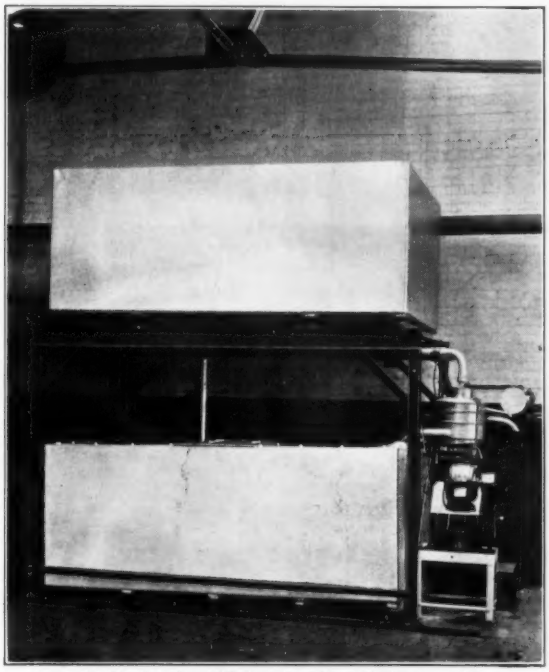
EBONITE AND ALL INSULATING MATERIAL FOR ELECTRICAL MANUFACTURERS

ATTWATER & SONS,

Established 1868.

PRESTON, ENGLAND.

Contractors to the British, American, French and Italian War Offices and Admiralties.



A De Laval installation for the dehydration of transformer oil at a well-known London Oil Company.

DE LAVAL
Transformer Oil Purifiers

Experience has shown the De Laval Open Type Purifier to be the best method for dehydrating the oil in ordinary Transformers, and the De Laval Non-Aerating Purifier for special types of Transformers.

The De Laval Open Type Purifiers are manufactured in six sizes, with capacities ranging from 20 to 1,500 gallons per hour; whilst the non-aerating type is only supplied in one size, having an hourly capacity of about 400 gallons.

With a De Laval Non-Aerating Oil Purifier, the oil in Conservator and Inertaire Transformers can be dehydrated without adding free or dissolved gases, or changing the oil level.

Both types of De Laval Transformer Oil Purifying Equipments can be used whilst the Transformers are on load.

For further particulars of both types of oil purifying equipments write to:—

ALFA-LAVAL Co., Ltd.,
34, Grosvenor Road, London, S.W. 1.
Telephone: Victoria 7174/5/6.

AS IN BLOCKMAKING - SO IN PHOTOGRAPHY.

QUALITY HAS ALWAYS BEEN OUR FIRST OBJECTIVE.

WE SEND OUR OWN PHOTOGRAPHERS TO ALL PARTS OF THE UNITED KINGDOM AND THE CONTINENT.

ALFRED CRASKE

MAKERS OF BETTER BLOCKS

5, EAST HARDING STREET, E.C.4.

Telephone CENTRAL, 2602, 2603 & 2646

All the Blocks used in the editorial section of this Journal were made by ALFRED CRASKE, LTD.

Are YOU interested in PAINTS for
MACHINE TOOLS or any kind of MACHINERY?
If so we commend to your notice

Strathclyde
REGISTERED TRADE MARK

ENAMEL FILLING
and
DULL STEEL-GREY PAINTS.

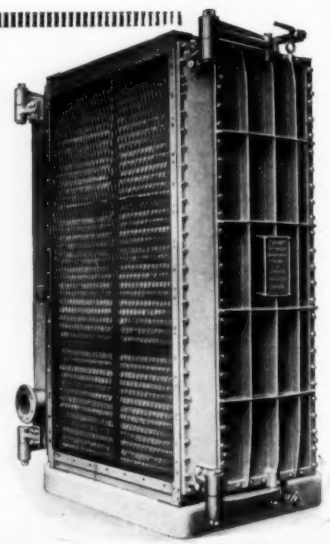
They are supplied in paste form and when thinned with Strathclyde Special Thinnings produce on any class of rough casting, the highest possible finish at the least possible expenditure of time and money. Samples and prices on request.

STRATHCLYDE PAINT CO., LD.,
DALMARNOCK, GLASGOW.

Contractors to Home & Colonial Govts.; The Leading Railway Co.'s; Car & Wagon Builders, Engineers, etc.

Heenan

ENCLOSED CIRCUIT AIR COOLERS
For the Safe Ventilation of Turbo-Alternators



A plentiful and continuous supply of cool, clean, dry air is assured by means of this system of ventilation. All dirt and free moisture are excluded and risk of fire reduced to a minimum. Moreover, these Coolers are simple to operate, reliable in action, inexpensive and suitable for working in conjunction with any make of alternator on the market.

The following is a Small Selection of Names of Purchasers :—

Aberdeen Corporation
British Admiralty
Barnsley Corporation
Bradford Corporation
Bedford Elec. Dept.
Brush Electrical Eng. Co. Ltd.
British Brown-Boveri Ltd.
British Thomson-Houston Co. Ltd.
Consett Iron & Steel Co. Ltd.
English Electric Co. Ltd.
Edinburgh Corporation
Formby Depot (L.M.S. Rly.)
General Electric Co. Ltd.
Glasgow Corporation
James Howden & Co. Ltd.
Hull Corporation
London Power Co. (Bow Road Stn.)
London Power Co. (Deptford Stn.)
Leicester Corporation
Lancs. Dynamo & Motor Co., Ltd.
Marylebone Corporatn.
Metropolitan-Vickers Electrical Co., Ltd.
Newport (Mon.) Corp.
Ocker Hill Con'ratg. Stn.
Oerlikon Ltd.
Peterboro' Corporation
Preston Corporation
Powell Duffryn S.C. Co. Ltd.
S. Wales Power Co Ltd.
Stepney, Met. Borough
Stockport Corporation
St. Pancras Boro' Coun.
Woolwich Corporation
Worcester Corporation
Yorks Elec. Power Co.
Auckland Pow. Stn. N.Z.
Adelaide Tramways
Athens, St. George's Power Stn.
Centrale de Droogen-bosch (Brussels)
Capetown Suburb'n Rly.
Eastern Bengal Rlys.
Perak Power Station
State Coal Mines (Holland)
Etc., Etc.

PLEASE SEND FOR OUR LITERATURE.

Heenan & Froude Ltd.,
Worcester, England.

COVENTRY ORDNANCE

High Speed Tools.

Twist Drills.
Milling Cutters.
Reamers.
Broaches.
Taps & Dies.
Boring Bars.
New Simplex Pneumatic Riveting Hammers & Drilling Machines.

Manufacturers:

The
ENGLISH ELECTRIC
Company Limited.
ORDNANCE WORKS, COVENTRY

The Whitehead Letter File Company

SPECIALITIES

COMBINE-LACE FILE
RODWELL FILE
AGRIPPA FILE
KLIPSPRING FILE
PRONG BINDER FILE
HOTSPUR RING BOOKS
OWL CLIPS
UNIVERSAL STORAGE CASE
HOTSPUR WALLET FOLDER
DOCUMENT WALLETS
GUIDES AND FOLDERS FOR VERTICAL FILING
ESTIMATE AND CATALOGUE COVERS

THE CATALOGUE OR ESTIMATE COVER you decide on must express your firm's personality.

No matter how interesting the contents, the recipient is prejudiced, either for or against, by the manner in which he receives them. He must be given the impression of quality yet not extravagance, of dignity—in short he must realise just those distinctive qualities which go to make up the personality of your firm.

WE do not issue a list of such covers, for every job is different. We make what you desire and at the same time offer suggestions based on our long experience of this class of work.

Hotspur Works, Powell Street, London, E.C.1.

PORCELAIN INSULATORS

EXTRA HIGH TENSION AND LOW TENSION

for

OVERHEAD POWER TRANSMISSION, TELEGRAPH AND TELEPHONE LINES, BUSHINGS, ACCESSORIES, &c., IN HIGHEST GRADE ELECTRICAL PORCELAIN.

"FISH-SPINE" INSULATING BEADS

for Bare-wire Insulation

TAYLOR, TUNNICLIFF & CO., LTD.

Head Office: EASTWOOD, HANLEY, STAFFS.

Telephone: Hanley 5272. Telegrams: Eastwood, Hanley

Works: HANLEY, STONE & LONGTON.

London Office: 110, CANNON STREET, E.C.4.

Telephone: City 6620.

"DAVY"

ROLLING MILL PLANT STEELWORKS & HYDRAULIC MACHINERY

Supplied to the principal Works all over the world for more than 50 years.

ROLLING MILLS
BLOOMING MILLS. REVERSING PLATE MILLS. THREE-HIGH PLATE MILLS. SECTION MILLS. MERCHANT MILLS. SHEET MILLS. "MORGAN" CONTINUOUS ROLLING MILL PLANTS. TYRE AND WHEEL MILLS. COLD ROLLING MILLS.

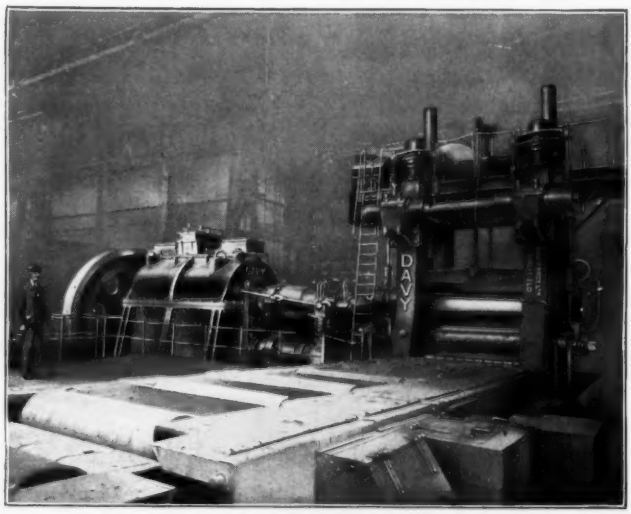
ACCESSORY MACHINERY
SHEARS. HOT SAWS. MANIPULATORS. ROLLER GEAR. INGOT TILTERS. ROLL LATHES, ETC.

HYDRAULIC MACHINERY
"DAVY" PATENT HIGH-SPEED FORGING PRESSES. HYDRAULIC PRESSES FOR FLANGING, EXTRUSION, CABLE COVERING, LEAD PIPES, ETC. HYDRAULIC PUMPS AND ACCUMULATORS. INTENSIFIERS. IMPROVED WORKING VALVES.

STEAM HAMMERS OF ALL TYPES.

STEAM BOILERS OF THE LANCASHIRE, CORNISH AND VERTICAL TYPES.

DAVY BROTHERS LTD.
Established 1830. SHEFFIELD.



32" x 6'-6" THREE-HIGH PLATE MILL.

CARTRIDGE FUSES

This type of construction readily lends itself to expansion.

Units can be built up to accommodate any number of ways for single, two or three-phase systems.

E.H.T. FUSE CUBICLES

These fuse cubicles are designed for working pressures of 2,200, 3,300 and 6,600 volts.

Maximum rating 400 kVA. per phase.

Guaranteed rupturing capacity of fuses 75,000 kVA. at 6,600 volts.

To comply with Home Office Regulations, the fuse mounted between isolating links is housed in such a manner that by a system of interlocked doors, access to the fuse cannot be obtained until the isolating link chamber doors have first been opened and then reclosed.

As illustrated, this apparatus is suitable for indoor use only. It is also incorporated in Kiosk Housings and when so used, forms a reliable unit for isolating and protecting distribution networks.

Write for Publication No. 975 which illustrates the many applications of these units.

The ENGLISH ELECTRIC Company Limited.

WORKS:- BRADFORD, COVENTRY, PRESTON, RUGBY, STAFFORD.
HEAD OFFICE:-

Queen's House, Kingsway, London, W.C.2.

INDEX TO ADVERTISERS

Alfa-Laval Co., Ltd.	XI
Associated British Machine Tool Makers, Ltd.	IV
Attwater & Sons	X
Bale, Stewart	V
Broadbent, Thos. & Sons, Ltd.	II
Craske, Alfred, Ltd....	XI
Davy Brothers Ltd.	XIV
D. P. Battery Co., Ltd.	IX
Electric Furnace Co., Ltd.	X
English Electric Company, Limited	XIII, XV
Equipment & Engineering Co. Ltd.	VI
Green, E. & Son, Ltd.	II
Heenan & Froude Ltd.	XII
London Electric Wire Co. & Smiths Ltd.	VI
Marelli & Co., Ltd.	VII
Mason, E. N., & Sons, Ltd.....	III
Renold, Hans, Ltd.	V
Siemens Electric Lamps & Supplies, Ltd.	VIII
Straker Brothers, Ltd.	XVI
Strathclyde Paint Co., Ltd.	XII
Taylor, Tunnicliff & Co., Ltd.	XIV
Whitehead Letter File Co.	XIII
Yorkshire Copper Works, Ltd.	I

All communications respecting Editorial Contents and Advertising Rates should be addressed to The Editor, The English Electric Journal, Queen's House, Kingsway, W.C.2.

When communicating with Advertisers please mention English Electric Journal.

The Bishopsgate Press

(Straker Brothers Limited)

Established 1800

Catalogue & Color Printers

Telegrams, "Straker London"

Telephone, Bishopsgate 2444 (4 Lines)

"Ye Olde Bishops Gate" 1620

We specialise in:-

CATALOGUES AND COLOUR PRINTING

ACCOUNT BOOKS INDEX SYSTEMS

DIE STAMPING OFFICE REQUISITES ETC. ETC.

194-200 Bishopsgate London E.C.2.

"Yorkshire"

TUBES

in

Copper, Brass, Aluminium Bronze, and Cupro - Nickel, for Power Stations.

CUPRO-NICKEL CONDENSER TUBES
(80/20, 70/30, 60/40. etc.)
AND OTHER ALLOYS.

BRASS CONDENSER TUBES in all standard and special mixtures including 70/29/1 (Admiralty), 70/30 and "Bemal."

YORKSHIRE
Nothing but Tubes
COPPER WORKS LTD

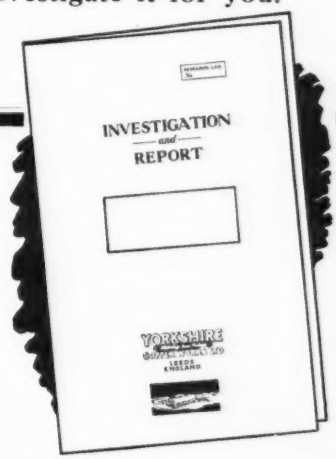
LEEDS, ENGLAND.
Telephones: 20031. *Telegrams:* "Tubes, Leeds."
LONDON OFFICE: 53, New Broad Street, E.C.2

THE PROBLEM OF CONDENSER TUBE FAILURE.

Our Laboratory and Research Department—with Chemists and Metallurgists highly skilled in the investigation of dezincification, corrosion-erosion, and other problems, is at your service.

Samples of Tubes are taken, tested and examined—a complete individual report on each problem being furnished without obligation.

Should you have a case of Condenser trouble, let us investigate it for you.



PORCELAIN INSULATORS

EXTRA HIGH TENSION AND LOW TENSION

for

OVERHEAD POWER TRANSMISSION, TELEGRAPH AND TELEPHONE LINES, BUSHINGS, ACCESSORIES, &c., IN HIGHEST GRADE ELECTRICAL PORCELAIN.

"FISH-SPINE" INSULATING BEADS

for Bare-wire Insulation

TAYLOR, TUNNICLIFF & CO., LTD.

Head Office: EASTWOOD, HANLEY, STAFFS.

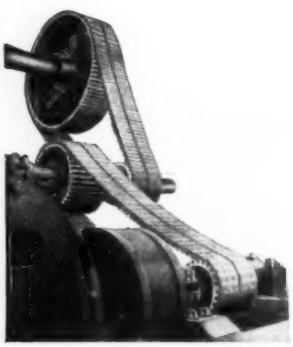
Telephone: Hanley 5272. Telegrams: Eastwood, Hanley

Works: HANLEY, STONE & LONGTON.

London Office: 110, CANNON STREET, E.C.4.

Telephone: City 6620.

Quick delivery of chain drives up to 600 h.p.



RENOLD Standard Design Drives meet general industrial transmission requirements.

They cover a full range of powers from 1 to 600 h.p. with a wide range of pinion speeds and ratios from 1 : 1 to 6 : 1.

Prices compare favourably with other forms of power transmission and quick delivery is offered for any drive in the series.

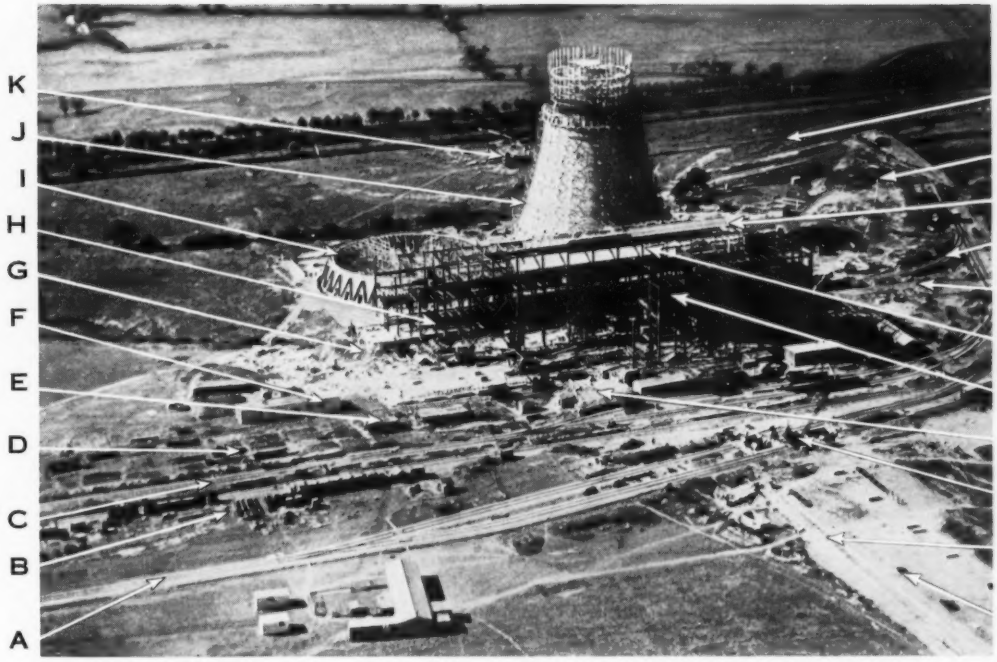
Full particulars are given in our booklet "Renold Standard Design Drives." Copies free on request.

RENOLD

STANDARD DESIGN DRIVES

HANS RENOLD LIMITED, DIDSBURY, MANCHESTER.

How A Comprehensive POWER STATION CONTRACT IS ORGANISED



HAMS HALL POWER STATION, BIRMINGHAM

Showing position of work twelve months after order was placed.

(A) Incoming tracks for full coal wagons.
(B) Store ground for manufactured supplies.
(C) Main incoming tracks for supplies.
(D) Store ground for all raw material—reinforced bars, steel structural work, etc.
(E) Steel bending sheds.
(F) Temporary shops.
(G) Foundation work in progress.
(H) Steel work erection in progress.
(I) Lower portion of second Cooling Tower Construction.
(J) First Cooling Tower.
(K) Intake screens and pump house for cooling water.
(L) Diverted stream for all water discharge.
(M) Embankment for railway sidings, garages, etc.
(N) Switch house roof.
(O) Railway sidings to loading bay.
(P) Roadway to loading bay.
(Q) Turbine house roof.
(R) Boiler house and coal bunkers.
(S) Central concrete mixing station.
(T) Coal wagon tippler pits in course of construction.
(U) Coal handling crane tracks.
(V) Coal handling plant foundations.

ALL CIVIL WORK, DRAINS, RAILWAY TRACKS, ROADS, STRUCTURAL AND BUILDING WORK, COOLING TOWERS, COAL AND ASH HANDLING PLANTS, ETC., CARRIED OUT FOR THE MAIN CONTRACTORS, MESSRS. INTERNATIONAL COMBUSTION LIMITED, BY

THE

MITCHELL CONVEYOR

COMPANY LIMITED,

ATLANTIC HOUSE,

45-50, HOLBORN VIADUCT, LONDON, E.C.1.

ST. GEORGE'S ENGINEERS, LTD.,

ORDSALL LANE, TRAFFORD BRIDGE, MANCHESTER.

TELEPHONE:
TRAFFORD PARK 1207 & 1208

TELEGRAMS:
"GEORGIC, MANCHESTER."

ELECTRICALLY WELDED STEEL PIPES.

BRANCH PIPES OF ANY SIZE

NO PATTERN REQUIRED

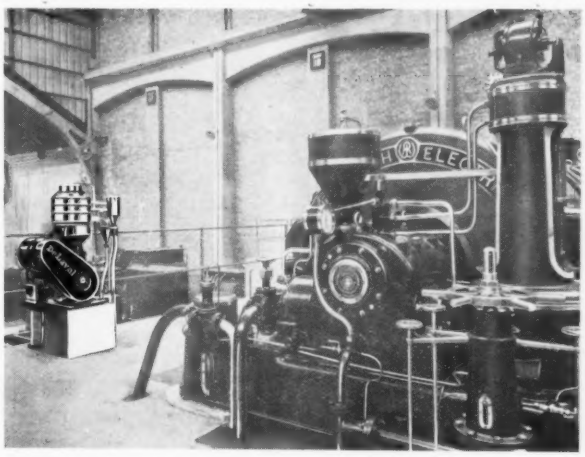
MADE TO WITHSTAND ANY TEST PRESSURE

TEMPLATE PIPES OF EVERY DESCRIPTION
MUCH LIGHTER THAN CASTINGS
MACHINED COMPLETE READY FOR FIXING
PIPES OF ANY SHAPE MADE TO CLIENTS DRAWINGS
QUICK DELIVERY—DESPATCHED BY ROAD FOR URGENT JOBS

SEND US PARTICULARS OF YOUR REQUIREMENTS WITH DIMENSIONS

MANUFACTURERS OF STEEL TANKS AND VESSELS OF ALL DESCRIPTIONS

DE LAVAL TURBINE OIL PURIFIERS.



De Laval Size 700 Oil Purifier installed on an "English Electric" Turbine.

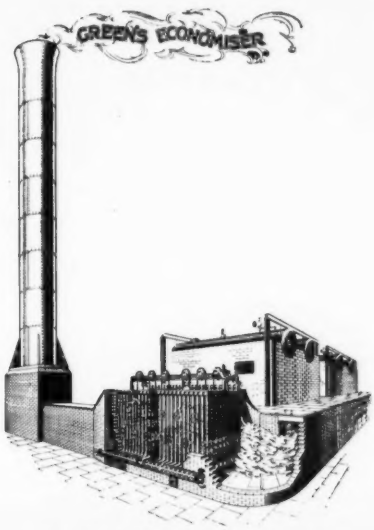
For best results, always use the De Laval Patented Bye-Pass System of Turbine Oil purification, thus ensuring that the oil in circulation is maintained in a good condition.

The following list gives the names of some of the turbine installations made by The English Electric Co. Ltd. where De Lavals have been supplied as a necessary auxiliary :—

Admiralty Dockyard, Malta.
The Admiralty, St. George's Bay, Athens.
Adelaide Tramways.
Epsom U.D.C. Electricity Department.
India Store Dept., Sukkor Barage.
Indore Electric Supply Co., India.
Leicester Corpn. Elec. Dept.
London, Midland & Scottish Rly.
Preston Corpn. Electricity Dept.
Peterborough Corpn. Elec. Dept.
Sheffield Corpn. Elec. Dept.
Wallasey Corpn. Elect. Dept.

ALFA-LAVAL COMPANY LTD.,
34, Grosvenor Road, London, S.W.1.

MORE STEAM WITH LESS COAL



Standard Vertical Economiser

There is no substitute for the

ECONOMISER

For lasting economy specify

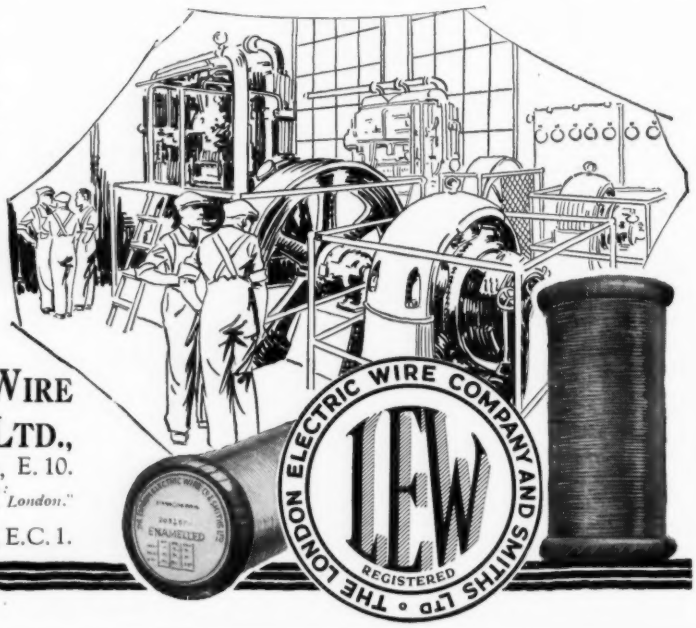
GREEN'S

Descriptive booklets, recommendations, estimates—free on application.

E. GREEN & SON, Ltd.
WAKEFIELD——————ENGLAND

Don't risk a breakdown!

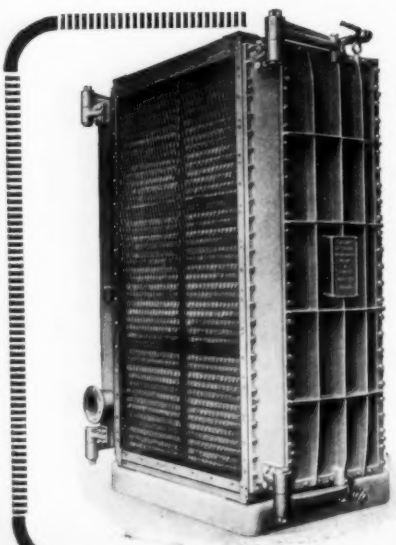
To buy cotton, silk or enamel insulated wire on price is "penny wise, pound foolish." By eliminating all risk of costly breakdowns, LEW wire is the cheapest in the long run. The LEW mark has set the highest standard for quality for over 50 years.



The
LONDON ELECTRIC WIRE COMPANY & SMITHS, LTD.,
Church Road, Leyton, London, E. 10.
'Phone: Walthamstow 2551. *'Grams: "Lewros, Phone, London."*
Trade Counter :—
7, Playhouse Yard, Golden Lane, E.C. 1.

Heenan

ENCLOSED CIRCUIT AIR COOLERS
For the Safe Ventilation of Turbo-Alternators



A plentiful and continuous supply of cool, clean, dry air is assured by means of this system of ventilation. All dirt and free moisture are excluded and risk of fire reduced to a minimum. Moreover, these Coolers are simple to operate, reliable in action, inexpensive and suitable for working in conjunction with any make of alternator on the market.

The following is a Small Selection of Names of Purchasers :—

Aberdeen Corporation
British Admiralty
Barnsley Corporation
Bradford Corporation
Bedford Elec. Dept.
Brush Electrical Eng. Co. Ltd.
British Brown-Boveri Ltd.
British Thomson-Houston Co. Ltd.
Consett Iron & Steel Co. Ltd.
English Electric Co. Ltd.
Edinburgh Corporation
Formby Depot (L.M.S. Rly.)
General Electric Co. Ltd.
Glasgow Corporation
James Howden & Co. Ltd.
Hull Corporation
London Power Co. (Bow Road Stn.)
London Power Co. (Deptford Stn.)
Leicester Corporation
Lancs. Dynamo & Motor Co., Ltd.
Marylebone Corporatn.
Metropolitan-Vickers Electrical Co., Ltd.
Newport (Mon.) Corp.
Ocker Hill Gen'ratg. Stn.
Oerlikon Ltd.
Peterboro' Corporation
Preston Corporation
Powell Duffryn S.C. Co. Ltd.
S. Wales Power Co Ltd.
Stepney, Met. Borough
Stockport Corporation
St. Pancras Boro' Coun.
Woolwich Corporation
Worcester Corporation
Yorks Elec. Power Co.
Auckland Pow. Stn. N.Z.
Adelaide Tramways
Athens, St. George's Power Stn.
Centrale de Droogen-bosch (Brussels)
Capetown Suburb'n Rly.
Eastern Bengal Rlys.
Ferak Power Station
Sta'e Coal Mines (Holland)
Etc., Etc.

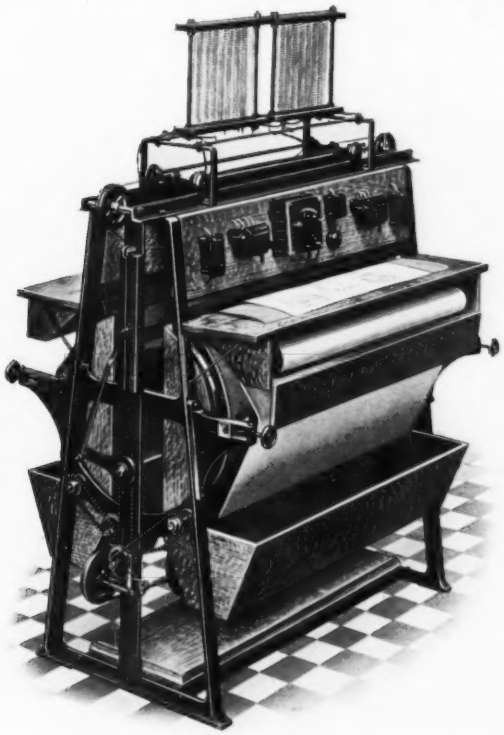
PLEASE SEND FOR OUR LITERATURE.

Heenan & Froude Ltd.,
Worcester, England.

E. N. MASON & SONS LIMITED

THE MANUFACTURING DRAWING OFFICE STATIONERS

"ARCLIGHT" CONTINUOUS HORIZONTAL ELECTRIC PHOTO COPIERS



RAPID & EFFICIENT PRODUCTION
LOW CAPITAL & MAINTENANCE COSTS

THE KEYNOTE OF SUCCESS

SIMPLICITY IN DESIGN
STURDY IN CONSTRUCTION
EFFICIENT IN PRODUCTION

PLEASE SEND FOR OUR COMPREHENSIVE AND FULLY ILLUSTRATED CATALOGUE OF THESE MACHINES.

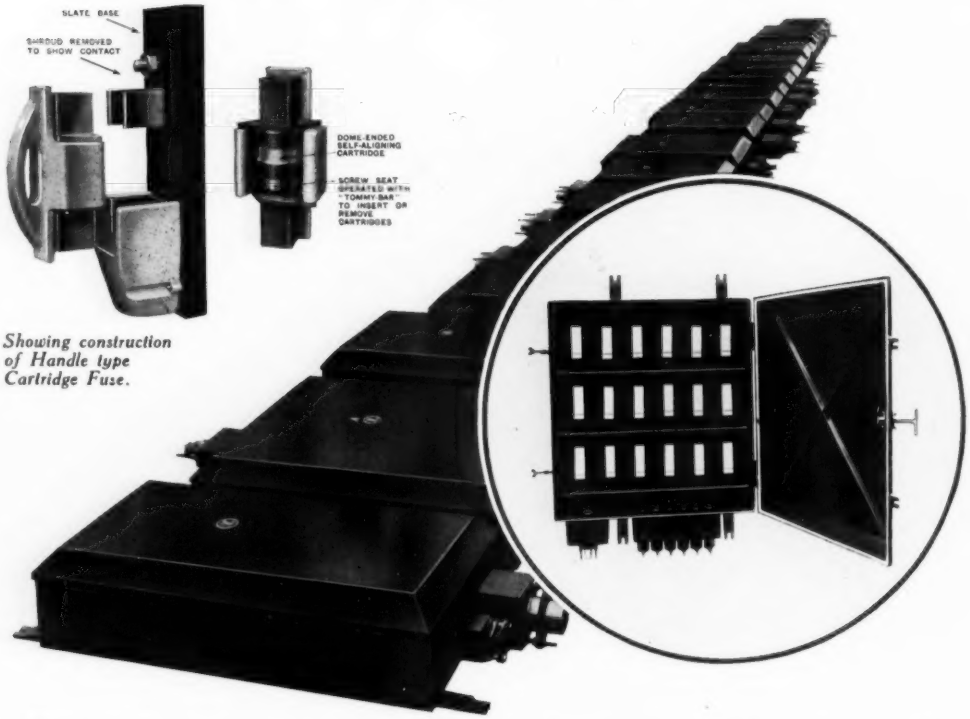
ARCLIGHT WORKS, COLCHESTER, ENGLAND.

LONDON — BIRMINGHAM — MANCHESTER — NEWCASTLE-ON-TYNE.

DISTRIBUTION BOARDS
FOR POWER CIRCUITS

SLATE BASE
SHROUD REMOVED TO SHOW CONTACT
DOME-ENDED SELF-ALIGNING CARTRIDGE
SCREW SEAT OPERATED WITH "TOMMY-BAR" TO INSERT OR REMOVE CARTRIDGES

Showing construction of Handle type Cartridge Fuse.



The Fuses are "English Electric" Handle-Cartridge type with a Guaranteed Rupturing Capacity of 25,000 k.V.A.

Range 0-800 amperes. For Working Pressures up to 750 volts.

Accurate Calibration. No Oxidation.

Comply with the latest relevant Home Office Rules.

The Cases are light-gauge steel reinforced on a unique system that gives the necessary strength with greatly reduced weight and full accessibility.

ASK FOR PUBLICATION No. 973.

ENGLISH ELECTRIC

THE ENGLISH ELECTRIC COMPANY LIMITED.

HEAD OFFICE:

Queen's House, Kingsway, London, W.C.2.

Works: BRADFORD, COVENTRY, PRESTON, RUGBY AND STAFFORD.

Are YOU interested in PAINTS for
MACHINE TOOLS or any kind of MACHINERY?
If so we commend to your notice

Strathclyde
REGISTERED TRADE MARK

ENAMEL FILLING
and
DULL STEEL-GREY PAINTS.

They are supplied in paste form and when thinned with Strathclyde Special Thinnings produce on any class of rough casting, the highest possible finish at the least possible expenditure of time and money. Samples and prices on request.

STRATHCLYDE PAINT CO., LD.,
DALMARNOCK, GLASGOW.

Contractors to Home & Colonial Govts.; The Leading Railway Co.'s; Car & Wagon Builders, Engineers, etc.

"DAVY"

ROLLING MILL PLANT
STEELWORKS & HYDRAULIC MACHINERY

Supplied to the principal Works all over the world for more than 50 years.

ROLLING MILLS
BLOOMING MILLS. REVERSING PLATE MILLS. THREE-HIGH PLATE MILLS. SECTION MILLS. MERCHANT MILLS. SHEET MILLS. "MORGAN" CONTINUOUS ROLLING MILL PLANTS. TYRE AND WHEEL MILLS. COLD ROLLING MILLS.

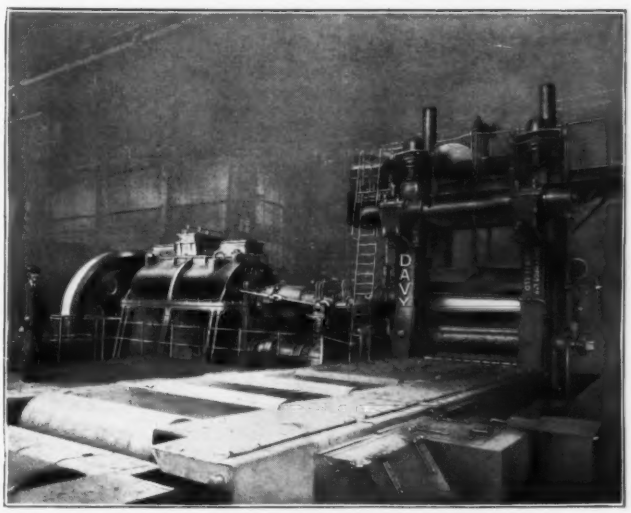
ACCESSORY MACHINERY
SHEARS. HOT SAWS. MANIPULATORS. ROLLER GEAR. INGOT TILTERS. ROLL LATHES, ETC.

HYDRAULIC MACHINERY
"DAVY" PATENT HIGH-SPEED FORGING PRESSES. HYDRAULIC PRESSES FOR FLANGING, EXTRUSION, CABLE COVERING, LEAD PIPES, ETC. HYDRAULIC PUMPS AND ACCUMULATORS. INTENSIFIERS. IMPROVED WORKING VALVES.

STEAM HAMMERS OF ALL TYPES.

STEAM BOILERS OF THE LANCASHIRE, CORNISH AND VERTICAL TYPES.

DAVY BROTHERS LTD.
Established 1830. SHEFFIELD.



32" x 6'-6" THREE-HIGH PLATE MILL.

In Colombo

Laying
SIEMENS

E. H. T. POWER CABLES

for

Power Distribution Scheme

Siemens products are of the highest quality and enjoy a world wide reputation

SIEMENS BROTHERS & CO., LTD.

WOOLWICH, LONDON, S. E. 18